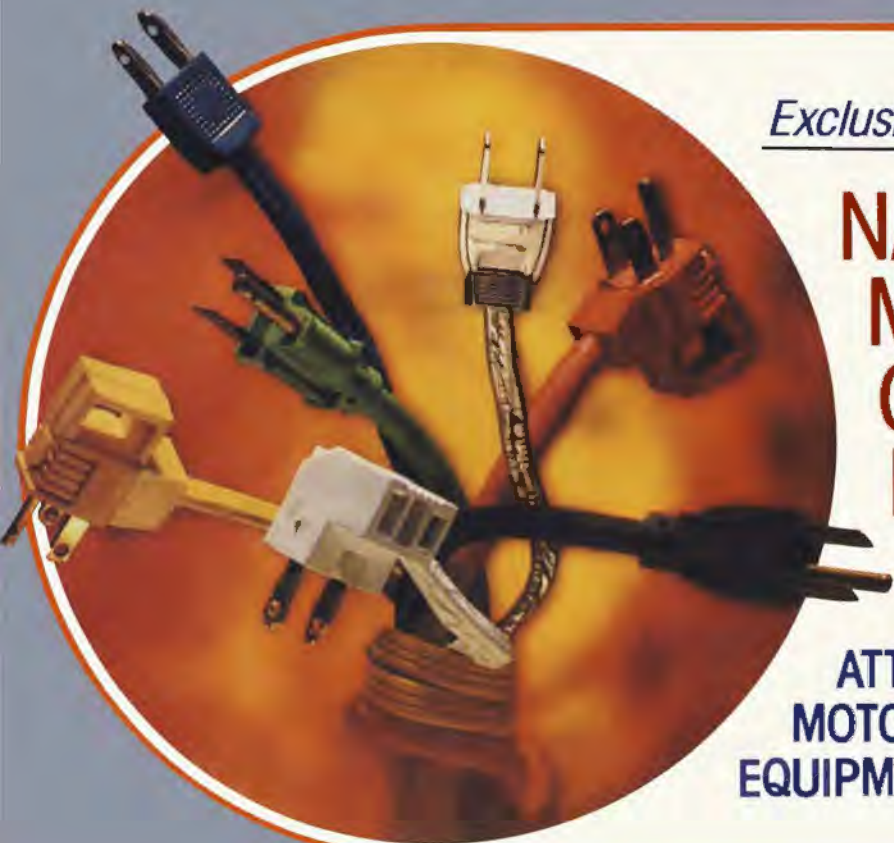


Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE OCTOBER 1979/\$1.25

25th ANNIVERSARY ISSUE
Special Focus on the Electronics Revolution



Exclusive Project!

NASA's New Motor-Control Circuit Cuts Electric Cost...

**UNDER-\$30 DEVICE
FOR REFRIGERATORS,
ATTIC FANS & OTHER
MOTOR-DRIVEN
EQUIPMENT**

Audio Meter Displays True Power
How to Add I/O Ports to Microcomputers
Strange TV Video Symptoms & Causes

**Tested
In This
Issue**

Pioneer TX-7800 AM-FM Tuner
Scott PRO-100B Speaker
Teac 124 Cassette Deck



Tomorrow's tools. For today's problems.

You might say we make time machines. CSC's smarter tools for testing and design help you make the most of your time in every corner of electronics, by working *smarter* instead of harder, for far less than you'd expect.

We give your head a head start with a variety of solderless breadboarding systems that let you translate ideas directly into working circuits, as fast as you can think.

We offer the most logical way to test logic — The Logical Force™ — portable, circuit-powered digital instruments that dramatically cut the time (and cost) of diagnosing state-oriented logic. Available singly or in Logical Analysis Test Kits. The Logical Force

simplifies design, maintenance, field service, education... wherever you need logical answers at a logical price.

Also instrumental in making life easier are CSC's value-packed test instruments. Including palm-size frequency counters that go from audio to past 550 MHz. Our Ultravari-able Pulse Generator™ that lives up to its name with a range of 0.5Hz to 5 MHz and a duty cycle variable over ten-million to-one. A function generator whose VCO is externally sweepable over 100:1.

There's a lot more, too. All in our new 38-page catalog, crammed full of smarter ideas in testing and design. Send for your free copy today.



Smarter tools for testing and design.

CONTINENTAL SPECIALTIES CORPORATION



Call toll-free for details
1-800-243-6077
8:30AM-5PM Eastern Time

70 Fulton Terr., New Haven, CT 06509 (203) 624-3103 TWX 710-465-1227
OTHER OFFICES: San Francisco (415) 421-8872 TWX 910-372-7992
Europe: CSC UK LTD. Phone Saffron Walden 0799-21682, TLX 817477
Canada: Len Funkley Ltd. Ontario

Available at selected local distributors. © Copyright 1979 Continental Specialties Corporation

CIRCLE NO. 17 ON FREE INFORMATION CARD

Endorsement Battle

NEW PRODUCT

A famous golf star endorses the Lanier. Our unit is endorsed by our president. You'll save \$100 as a result.



We not only took the unit apart, we examined our competition as well.

Judge for yourself. That new Olympus micro recorder shown above sells for \$150. Its closest competition is a \$250 recorder called the Lanier endorsed by a famous golf star.

FANCY ENDORSEMENT

The famous golf star is a pilot who personally flies his own Citation jet. The Olympus recorder is endorsed by JS&A's president who pilots a more cost-efficient single engine Beachcraft Bonanza. The golf star does not endorse the Lanier unit for free. After all, a good portion of his income is derived from endorsing products.

Our president, on the other hand, does not get paid for endorsing products—just for selling them. And his Bonanza is not as expensive to fly as the golf star's Citation. In fact, our president also drives a Volkswagen Rabbit.

SOLD DIFFERENTLY

The Lanier is sold through a national network of direct salesmen similar to the IBM sales force. Naturally, these salesmen must be paid expenses and commission.

JS&A efficiently sells the Olympus through this advertisement—a very direct and inexpensive way to market a product.

With less overhead, no direct national sales staff, and no expensive endorsements, Olympus can sell its recorder for less money to JS&A. And with our company's efficiency, we can sell you practically the same recorder as the Lanier for much less—a savings of \$100.

Is the Olympus better than the Lanier for less money? We weren't sure, so we took them both apart and what we found amazed us. Other than a slight size difference, the units were practically identical. For example:

CORELESS MOTOR

Both units have the new coreless motor. Conventional motors require a long and heavy solid core that is wirewound. In a coreless motor, the windings are on the outside or stationary part of the motor making it flatter, yet it has greater initial torque and more consistent speed than any other conventional motor.

THE FERRITE HEAD

Both units use ferrite for their recording heads—the same material used in precision studio recorders. This extremely hard, diamond-like material will last a lifetime and prevents oxide build-up.

A NEW KIND OF MIKE

Both units also use an electret condenser microphone with automatic level control. In an electret system, the impedance of the microphone remains constant, thus passing on the natural sound quality of all frequencies without distortion. The result is a clear recording with an extremely low signal-to-noise ratio, so you'll hear less objectionable background hissing or humming.

MANY SIMILAR FEATURES

Both units use the microcassette tapes that play 30 minutes per side. The Olympus measures only 1" x 2½" x 4⅞" and weighs only 9 ounces. The Lanier is the same weight as the Olympus and measures only ⅞" x 2½" x 4"—practically the same size.

HERE'S OUR PLAN

But prove it to yourself. Order an Olympus recorder from JS&A. After you receive it, call in your Lanier sales representative. Have him bring you a sample of his unit. (You might even check to see what kind of car the salesman drives.) Then make a side-by-side comparison. Compare both units feature for feature



Micro cassettes are the newest recording medium. Each cassette will record for 30 minutes per side.

and see how much better the Olympus sounds. Then carry them both in your pocket and on trips. Use them at meetings or while you drive in your car. Really give them both a workout.

Then decide. If you don't feel that the Olympus is as good a unit or better than the Lanier for \$100 less, simply return the Olympus within 30 days for a prompt refund and then purchase the Lanier unit, keeping

one of our tapes as a gift. If you decide to keep the Olympus, consider yourself a smart shopper. Anyone who would take the time to read this advertisement and take the action to order and test the Olympus unit, deserves to save \$100.

SERVICE AT ITS BEST

Both the Lanier and the Olympus units are solidly backed by efficient service organizations. Olympus has an outstanding service-by-mail facility so no matter where you live, just slip your unit in its handy mailer and send it in. Olympus is the same company that manufactures high quality precision cameras and optics, and JS&A is America's largest single source of space-age products—further assurances that your modest investment is well protected.

To order your Olympus unit for our comparison trial, send your check for \$150 plus \$3.50 for postage and handling to: JS&A Group, Inc., One JS&A Plaza, Northbrook, Illinois 60062. (Illinois residents add 5% sales tax.) Credit card buyers may call our toll-free number below. We will promptly ship your unit, one free tape, complete instructions, and one-year warranty. If you wish to order additional cassettes, you may order them for \$3 each or \$15 for a package of five (our minimum quantity).

CONSUMERS CAN BENEFIT

Endorsements are very helpful when you sell products. They attract attention and give consumers confidence that their purchase is also used by someone famous. But indirectly, consumers pay for endorsements. They also pay for a large sales force and less efficient marketing methods.

When you purchase an Olympus from JS&A, you pay for just what you get. A great product. Why not order an Olympus recorder at no obligation, today?

JS&A PRODUCTS THAT THINK®

Dept. PE One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-7000
Call TOLL-FREE 800 323-6400
In Illinois Call (312) 564-7000

© JS&A Group, Inc., 1979

When you're not available, Phone-mate's Remote 930 is!

Our Telephone Products Division of Communications Electronics™ is pleased to introduce the new and improved Phone-mate Remote 930 telephone answering system. Unlike other telephone answerers, the Remote 930 has many useful and unique features not available on any other machine at any price. Features such as a LED digital message counter and Audio-Scan™ are standard on the Remote 930.

You can connect your Remote 930 to any phone system including the new "com-key" and private business systems. More importantly, the Remote 930 has built-in fail-safe features controlled by an internal computer to correct common user mistakes.

The incredible, new Phone-mate Remote 930 gives you complete control of all calls while you're away!

MANY IMPORTANT FEATURES

Only the Remote 930 gives you so many important features such as call monitor, ring adjust and remote control. You can retrieve your messages from anywhere in the world by calling in from any telephone, anywhere, anytime. Sound your coded pocket tone key and hear your messages played over the phone in complete privacy. The Remote 930 is your 24 hour message center for business contacts, family and friends.

SAVE TIME AND MONEY!

Save valuable time and money when retrieving messages by remote control. One phone call plays all messages as many times as you like without requiring you to hang up and call again. The remote backspace feature allows you to replay individual messages instantly without waiting for the entire tape to rewind and replay.

C-VOX™ AN EXCLUSIVE FEATURE

Controlled Voice Activation will allow your caller to leave a lengthy or involved message, but will also let you set a maximum time limit. With the Voice Controlled Announcement feature, you can tailor your personal outgoing message to any length, up to 30 seconds. A single control knob for operational simplicity can be set for: Record Calls, Playback Calls, Record Two-Way Conversations, Tape Record/Dictation, Record Announcement and Announce Only. A LED Digital Message Counter instantly indicates (up to 99) how many messages you have received. The counter also functions as a "timer" to let you know the precise length of your outgoing message.

The Remote 930 uses readily available, reliable cassettes that pop in and out instantly. Messages can then be stored for future reference.

FAIL-SAFE DESIGN

Advanced computer technology, unavailable until now, has been designed into the Remote 930. The specially engineered microprocessor has been programmed to recognize user mistakes and automatically correct them. For example, when the incoming message tape is full, some systems will not answer the phone. This means you would not be able to access your system to retrieve calls. However with the Remote 930, when an incoming message tape is completely filled, the machine will allow you to playback your messages and also respond to all remote commands. This is only one of several built-in self-correcting back-up measures to insure ultimate reliability and ease of operation.

TEST IT FREE FOR 31 DAYS!

Test a Phone-mate Remote 930 FREE for 31 days. Because the Remote 930 is such a new and improved answering system, we want you to put it to the test at your office or home for 31 days before you decide to keep it. Check out the unique features that put the Remote 930 in a class by itself. See how the handsome woodgrain styling and compact size complement any home or office. Notice how effectively the Remote 930 will take your every call and give you your messages exactly as you received them. If for any reason you are not completely satisfied, we insist that you return it in new condition with all enclosed parts in 31 days, for a prompt refund.

phone·mate



COMPLETE NATIONAL SERVICE

With your Phone-mate Remote 930, we will send a complete set of simple operating instructions and a one-year limited warranty on parts and 90 days on labor. If service is ever required on any Phone-mate product purchased from Communications Electronics, simply send your system to one of our approved national service centers. When you purchase your telephone answering system from CE, you're buying from one of the world's leaders in high technology electronics.

MADE BY PHONE-MATE QUALITY CHECKED BY CE

Since all Remote 930 telephone answering systems sold by Communications Electronics are products of Phone-mate, the company that pioneered consumer answering devices, you can be assured of purchasing the finest and most reliable telephone answering machine in the world. In addition, our Quality Control Department further audits the quality of every Phone-mate model sold by us to ensure the high reliability found in all Phone-mate answering devices. CE has given the Remote 930 our quality controlling #1, which is our highest quality grade for technologically sophisticated equipment.

BUY WITH CONFIDENCE

The Remote 930 is an extraordinary telephone message center. It provides virtually any answering and message processing features that the most demanding businessperson could require. To order the world's only computer controlled and fail-safe engineered remote controlled answering system, send or phone your order directly to our Telephone Products Division. Mail orders to: Communications Electronics, Box 1002, Ann Arbor, Michigan 48106 U.S.A. Send \$299.95 plus \$5.00 for U.P.S. U.S. shipping for each Remote 930 system. If you have more than one person using your system, we suggest that you purchase an extra remote pocket tone key for every person authorized to receive messages at \$29.95 each. Prices and specifications are subject to change without notice. No COD's please. Cashier's checks and credit card order will be processed immediately. All sales are subject to availability, but because this is the most fantastic answering device that CE has ever offered, we have reserved enough units for immediate shipment. If you have a Master Charge or Visa card, you may call anytime and place a credit card order. Dial toll free 800-521-4414. International orders are invited at slightly higher cost. If you are outside the U.S. or in Michigan, dial anytime 313-994-4444. Michigan residents please add 4% tax. All order lines at CE are staffed 24 hours, seven days a week.

Due to the high demand for this most exciting and useful telephone answering system, please place your order today without obligation, to assure prompt delivery.

Copyright © 1979 Communications Electronics™



COMMUNICATIONS ELECTRONICS™

854 Phoenix □ Box 1002 □ Ann Arbor, Michigan 48106 U.S.A.
Call TOLL-FREE (800) 521-4414 or outside U.S.A. (313) 994-4444

We're first with the best.™

CIRCLE NO. 1 ON FREE INFORMATION CARD

Other Phone-mate® Remote 930 Features:

- **Exclusive C-VOX**—Controlled Voice Activation means your caller has time to leave a long or involved message. As long as C-VOX™ recognizes the sound of a voice it will continue to record, making it ideal for detailed job orders or messages.
- **Remote Control Feature**—Hear your messages played back over the phone from any phone, anywhere by sounding your coded pocket tone key. Backspace to repeat message or backspace directly to the message desired. Erase/Store messages...you can reset back to the beginning, record new messages over old ones, or continue recording after old ones to save them.
- **Fail-Safe Design**—Advanced computer technology in the Remote 930 represents a major breakthrough in telephone answerers. The Remote 930's specially designed and engineered microprocessor is programmed to recognize user mistakes and automatically correct them. The built-in self-correcting back-up features insure ultimate reliability and ease of operation.
- **Dual Cassettes**—means versatility and convenience. By keeping your incoming messages and outgoing announcements on separate tapes, you can file important messages for future reference while also establishing an "Announcement Library" for recurring needs.
- **Useful for Dictating Ideas**—Use the Remote 930 as a tape recorder or for dictation, then file the cassette or have it ready for transcription.
- **Change Tape Without a Service Call**—Unlike reel-to-reel answerers, the Phone-mate's dual cassette system allows you to quickly change tapes without the inconvenience and expense of having a technician do it for you.
- **Voice Controlled Announcement**—Allows you to tailor your outgoing message. The voice controlled announcement feature, with automatic level control, lets you record outgoing announcements up to 30 seconds in length. This eliminates the inconvenience of having to rehearse and time messages to fit a fixed time limit.
- **Call Monitor**—screens your calls and eliminates unwanted interruptions by letting you hear who's calling without touching your phone or letting the caller know you're there. If you wish to talk, just pick up the phone. If not, let Phone-mate take the message and return the call at your convenience.
- **Record Two-Way Conversations**—Keep a record of important conversations. Phone-mate records both sides of important telephone conversations. This enables you to keep a record of negotiations, orders or appointments.
- **Audio-Scan™**—Designed to help you locate your messages fast. The specially engineered cassette system enables you to hear messages in rewind or fast-forward. This lets you locate specific messages rapidly for instant replay. Fast-forward moves the tape rapidly past unwanted messages.
- **Ring Adjust**—Phone-mate answers when you want it to. Adjust your Phone-mate to answer on any ring one through five, and leave it on at all times. When you're in, you have ample time to answer the phone yourself. If you're away, Phone-mate will take the call for you. Never worry about remembering to always turn your machine "on" when you leave. This protects you from the "telephone burglar." Your phone is never left to ring and ring unanswered...a sure signal that no one is home, and an open invitation to burglary.
- **Announce Only**—Broadcast important information. The announce only feature lets you give each caller an announcement message without recording an incoming message. Ideal to announce business hours, vacation schedules, movie times, etc. The message counter always operates, so you know how many people have called and heard your message. Great for tabulating calls in telephone surveys, etc.
- **Communications Electronics™**—quality control approval rating #1. Our highest quality grade for FCC certified technologically sophisticated telephone equipment.
- **LED Power On Light**—tells if your unit is on and functioning without examining power knobs.
- **LED Digital Message Counter**—Indicates how many messages you have received. The counter also functions as a "timer" to let you know the precise length of your outgoing announcement.
- **Manual Erase**—allows you to erase previous messages when rewinding.
- **FCC Registered**—Conforms to all requirements for plug-in connection to a standard phone company modular jack.
- **Power**—Regular 110V AC; 60 Hz. house current.
- **Warranty**—1 year parts, 90 days labor.
- **Dimensions**—8¾" Wide, 11¼" Deep, 3½" High
- **Shipping Weight**—3.18 Kilograms, 7 pounds

POPULAR ELECTRONICS



About the cover:

PE celebrates its twenty-fifth anniversary with a breakthrough article designed to save energy on motor-driven electrical appliances.

Cover photo by Don Carroll

JOSEPH E. MESICS
Publisher

ARTHUR P. SALSBERG
Editorial Director

LESLIE SOLOMON
Technical Director

JOHN J. McVEIGH
Technical Editor

JOHN R. RIGGS
Managing Editor

HAROLD A. RODGERS
Senior Editor

ALEXANDER W. BURAWA
Features Editor

EDWARD I. RUXBAUM
Art Director

ANDRE DUZANT
Technical Illustrator

CARMEN VELAZQUEZ
Production Editor

BETTY LOUISE KNOWLES
Editorial Assistant

Contributing Editors
 Hal Chamberlin, Lou Garner, Glenn Hauser
 Julian Hirsch, Forrest Mims

JEFF NEWMAN
Assistant to the Editor

LINDA BLUM
Advertising Service Manager

MARIE MAESTRI
Executive Assistant

EDGAR W. HOPPER
Publishing Director

25th Anniversary Issue

The Past . . . Present . . . and Future

• Breakthrough Project:	
NASA MOTOR-CONTROL CIRCUIT CUTS ELECTRIC COST / Myles H. Marks	39
• The Microcomputer:	
AN EVOLVING REVOLUTION IN CONSUMER ELECTRONICS / James T. Van Tassel	44
• Editorial:	
A SIXTY-YEAR-OLD ELECTRONICS PUBLISHING HERITAGE / Art Salsberg	6
• Solid State:	
DOWN NOSTALGIA LANE / Lou Garner	86
• Amateur Radio:	
THOSE GOLDEN OLDIES / Karl T. Thurber	93

Feature Articles

HOW TO ADD I/O PORTS TO MICROCOMPUTERS / Adolph A. Mangieri	50
TEN UNCOMMON TV-RECEIVER PROBLEMS / Homer L. Davidson	58
HOW TO IMPROVE SW RECEIVER TUNING ACCURACY / James T. Hall	80
ENGLISH BROADCASTS AUDIBLE IN NORTH AMERICA / Glenn Hauser	108

Construction Articles

AUDIO POWER METER / John R. Hunt	62
ELECTRONIC SCOREKEEPER FOR RECREATION ROOMS / Joseph Fortuna	74
ACCURATE TIMEBASE FOR DIGITAL ELECTRONIC CLOCKS / William D. Kraengel	76

Columns

STEREO SCENE / Harold A. Rodgers	20
HOBBY SCENE / John J. McVeigh	84
EXPERIMENTER'S CORNER / Forrest M. Mims	97
COMPUTER BITS / Leslie Solomon	100
SOFTWARE SOURCES / Leslie Solomon	103
PROJECT OF THE MONTH / Forrest M. Mims	113

Julian Hirsch Audio Reports

H.H. SCOTT MODEL PRO 100B SPEAKER SYSTEM	24
PIONEER MODEL TX-7800 AM/FM STEREO TUNER	28
TEAC MODEL 124 STEREO CASSETTE DECK	30

Electronic Product Test Report

McKAY DYMEK MODEL DR33C COMMUNICATION RECEIVER	82
--	----

Departments

LETTERS	8
OUT OF TUNE	8
NEW PRODUCTS	10
TIPS & TECHNIQUES	85
OPERATION ASSIST.	106
ELECTRONICS LIBRARY	124
PERSONAL ELECTRONICS NEWS	132

POPULAR ELECTRONICS (ISSN 0032-4485): Published monthly by Ziff-Davis Publishing Company, at One Park Avenue, New York, NY 10016. Philip B. Korsant, President, Selwyn Taubman, Treasurer; Philip Sine, Secretary. One year subscription, U.S. and Possessions, \$13.00; Canada, \$16.00; all other countries, \$18.00, cash orders only, payable in U.S. currency. COPYRIGHT © BY ZIFF-DAVIS PUBLISHING COMPANY. ALL RIGHTS RESERVED.

ZIFF-DAVIS PUBLISHING COMPANY
Editorial and Executive Offices
One Park Avenue, New York, New York 10016
212-725-3500

Joseph E. Mesics (725-3568)
John J. Corton (725-3578)

Bonnie B. Kaiser, Eastern Adv. Mgr., (725-3580)

Midwestern Office

Ted Welch

Suite 1400, 180 N. Michigan Ave.,
Chicago, IL 60601 (312-346-2600)

Western Office

9025 Wilshire Boulevard, Beverly Hills, CA 90211
213-273-8050;

Western Representative: Norm Schindler

7050 Owensmouth Ave., #209

Canoga Park, CA 91303 (213-999-1414)

Japan: James Yagi, Oji Palace Aoyama;
6-25, Minami Aoyama, 6 Chome, Minato-Ku,
Tokyo, 407-1930/6821, 582-2851

ZIFF-DAVIS PUBLISHING COMPANY

Philip B. Korsant, President

Furman Hebb, Executive Vice President

Phillip T. Heffernan, Sr. Vice President

Edward D. Muhlfeld, Sr. Vice President

Philip Sine, Sr. Vice President, Secretary

Lawrence Sporn, Vice President, Circulation and Marketing

Richard Friese, Sr. Vice President

Baird Davis, Vice President, Production

George Morrissey, Vice President

Sydney H. Rogers, Vice President

Sidney Holtz, Vice President

Albert S. Traina, Vice President

Paul H. Chook, Vice President

Edgar W. Hopper, Vice President

Robert N. Bavler, Jr., Vice President

Selwyn Taubman, Treasurer

W. Bradford Briggs, Vice Chairman

ZIFF CORPORATION

William Ziff, Chairman

I. Martin Pompadour, President

Hershel B. Sarbin, Executive Vice President

POPULAR ELECTRONICS, October 1979, Volume 16, Number 4. Published monthly at One Park Avenue, New York, NY 10016. One year subscription rate for U.S. and Possessions, \$13.00; Canada, \$16.00; all other countries, \$18.00 (cash orders only, payable in U.S. currency). Second class postage paid at New York, NY and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada, and for payment of postage in cash.

POPULAR ELECTRONICS including ELECTRONICS WORLD. Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature.

COPYRIGHT © 1979 BY ZIFF-DAVIS PUBLISHING COMPANY. ALL RIGHTS RESERVED.

Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Popular Photography, Skiing, Stereo Review, Electronic Experimenter's Handbook, Tape Recording & Buying Guide, Stereo Directory & Buying Guide, and Communications Handbook.

Material in this publication may not be reproduced in any form without permission. Requests for permission should be directed to Jerry Schneider, Rights and Permissions, Ziff-Davis Publishing Co., One Park Ave., New York, NY 10016.

Editorial correspondence: POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of manuscripts, art work, or models.

Forms 3579 and all subscription correspondence: POPULAR ELECTRONICS, Circulation Dept., P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address. Include your old address, enclosing, if possible, an address label from a recent issue.

The publisher has no knowledge of any proprietary rights which will be violated by the making or using of any items disclosed in this issue.



Member Audit Bureau
of Circulations



Editorial

A SIXTY-YEAR-OLD ELECTRONICS PUBLISHING HERITAGE

POPULAR ELECTRONICS is now 25 years old, publishing its 300th issue last month. In truth, its lineage really extends back *sixty years* since it was spawned out of the pages of *Radio & TV News*, which started publishing life as *Radio Amateur News* in 1919. (Genealogically, *Radio Amateur News* was the begetter of *Radio News* which, in turn, begat *Radio & TV News*, which begat both *Electronics World* and POPULAR ELECTRONICS, the former merging into PE in 1972.)

The past quarter of a century was, of course, the period in which electronics truly blossomed. The very first issue of POPULAR ELECTRONICS, October 1954, observed that it is devoted to the science of electronics at the how-it-works, why-it-works, how-to-do-it and how-to-use-it level. The lead article was written by "Solid State" columnist Lou Garner: "Build Your Own Bike Radio," a four-tube battery-powered radio that attached to a bicycle's handle bars with "U" bolts. And John Frye's "Carl and Jerry" column titillated readers.

In keeping with PE's quest to present exciting, up-to-date electronics information for active enthusiasts, the following year covered such topics as: "A Scintillation Counter" to detect and measure atomic radiation; "Market Survey of Geiger Counters" accompanied by a build-your-own device; President Eisenhower's announcement of plans to launch a small, unmanned satellite for communication purposes; the beginning of an audio and hi-fi section; solar battery experiments; and the first "Transistor Topics" column.

The May 1956 cover story was "The Truth about Radar Speed Traps." In 1958, there were articles on "The Language of Digital Computers," "Play Games with Nixie® Tubes," "3D Color TV with Glasses," "Go Mobile with Audio Fi Speakers," and "Electronic Robots."

In 1959, PE had articles on Citizens Band Radios, a new Color TV Projection System (called Eidophor), "Stereo Records—Fad or Fulfillment?" "Special Report on Color TV," "Understanding Transistor Circuits," "Hams Go Video," and a special Hi-Fi Stereo issue. That was also the year when PE changed from pulp paper to smooth, "slick" paper.

Readers in the early-Sixties cut their eyeteeth on Dave Weems' "Sweet Sixteen Speakers" (16 small speakers working in unison to produce resoundingly deep bass), "An Introduction to Logic Circuits," "Build a One-Tube Radiation Fallout Monitor," "A Transistorized Car Ignition System," "Air Suspension Speaker Systems," "Home Video Tape Recording—When?" "TV Pictures on Phono Discs" (Westinghouse's "Phonovid"), "A White-Noise Generator to Aid Sleep," and "Build a Field-Effect Transistor Voltmeter" (a 2N2498 cost \$12.75 then).

In 1966, there were articles about the integrated circuit and its bright future, and "The Logic Demon" (a logic-function demonstrator project that used integrated circuits). This was followed in 1967 with "The Brute 70," a project to build a 70 watts rms audio power amplifier.

The year 1968 was truly a "breakthrough" one with Don Lancaster's \$12/decade counting unit project. And the decade ended with PE's publication of Dan Meyer's "Tiger Amplifier" audio projects (which were low-cost 40-to-100-W power amps), "A Dwell Extender for Ignition Systems," a "Logic Probe and Pulser," an "Experimenter's Laser," and a "Hand-Held Op-Amp Tach."

(Continued on page 6)

Here it is at last... **THE FIRST FLOPPY DISK BASED COMPUTER FOR UNDER \$1000**



The C1P MF
\$995

- Complete mini-floppy computer system
- 10K ROM and 12K RAM
- Instant program and data retrieval

The Challenger 1P Mini-disk system features Ohio Scientific's ultra-fast BASIC-in-ROM, full graphics display capability and a large library of instant loading personal applications software on mini-floppies including programs for entertainment, education, personal finance, small business and now *home control!*

Or Start with the C1P CASSETTE BASED Computer for just \$349.

The cassette based Challenger 1P offers the same great features of the mini-disk system including a large software library except it has 4K RAM and conservative program retrieval time. Once familiar with personal computers, you'll be anxious to expand your system to the more powerful C1P MF.

You can move up to mini-disk performance at any time by adding more memory and the disk drive. Contact your local Ohio Scientific dealer or the factory today.

*Both systems require a video monitor, modified TV or RF converter and home television for operation. Ohio Scientific offers the AC-3 combination 12" black and white TV/monitor for use with either system at \$115.00 retail.

All prices, suggested retail.



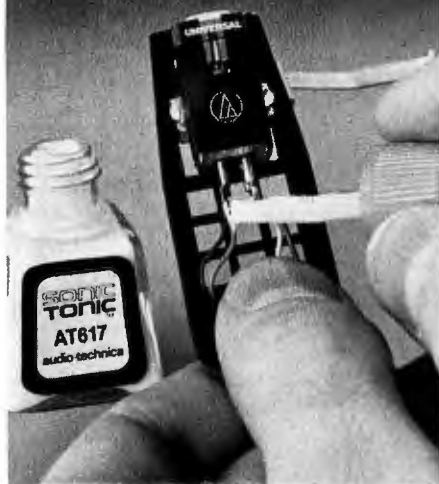
The C1P MF configuration is very powerful. However, to meet your growth needs it can be directly expanded to 32K static RAM and a second floppy by simply plugging these options in. It also supports a printer, modem, real time clock and AC remote interface as well as the OS-65D V3.0 development oriented operating system.

OHIO SCIENTIFIC

1333 S. CHILLICOTHE RD., AURORA, OHIO 44202 (216) 562-3101

Unique New SONIC TONIC™

Vibration Damping Compound from Audio-Technica



Liquid touch-up for the golden ear!

Sonic Tonic is a viscous damping material created to control and subdue small resonances in your system. It stops the tiny vibrations which may spoil an otherwise clean-sounding signal.

For instance, at low recorded levels your phono may sound fine. But at high levels perhaps an unsupported tone arm lead vibrates ever so slightly, adding a "sonic haze" to everything you hear.

Simply add a thin coating of Sonic Tonic. It goes on white, and dries in minutes to a clear yet always resilient coating. Sonic Tonic adds almost no mass, but—because it never fully hardens—it soaks up small vibrations like a sponge soaks up water.

Sonic Tonic can be applied almost anywhere to metal and most plastic surfaces. Use it on speaker voice coil wires, cartridge leads, tone arm shells and fingerlifts, turntable springs or wherever subtle control is needed. Sonic Tonic withstands normal handling, yet peels off readily if you change your mind.

If you're seeking perfection, Sonic Tonic is a helpful new finishing touch. Just \$6.95 for a bottle of AT617 Sonic Tonic, complete with applicator cap. At your Audio-Technica dealer's today.



audio-technica.
INNOVATION □ PRECISION □ INTEGRITY

AUDIO-TECHNICA U.S., INC.
Dept. 109P, 33 Shiloh Avenue
Fairlawn, Ohio 44131

CIRCLE NO. 11 ON FREE INFORMATION CARD

EDITORIAL continued

In 1970, PE's "Laser Beam Communicator" wound up at the Smithsonian Institution's National Museum of History. The new decade brought a "new look" to PE, too. Its logo and type face were changed, and the editorial thrust was directed even more toward the serious electronics enthusiast. This marked a new maturity on the part of readers, whom research studies indicated were more technically knowledgeable than were earlier readers and enjoyed a higher income.

A host of construction projects on products not previously available to readers at low cost followed: George Meyerle's graphic stereo tone-control system, a mini DVM, a digital clock, an electronic desk calculator, a TV preamp for blacked-out sports transmissions, the "Drummer Boy" rhythm maker for musical instruments, an "Alpha Brain-Wave Monitor," a "Super Audio Sweep Generator" that essentially launched function generators as basic test instruments outside professional labs, and other "breakthrough" articles.

Emerging from the pages of POPULAR ELECTRONICS in 1973 and 1974 were such innovative projects as an "Electronic Digital Wristwatch" for under \$80 when commercial equivalents were selling for upwards of \$200, and an impressive ESP test machine, among others.

PE's size was changed to its present large format in August 1974 to accommodate more complex schematics and foil patterns. Articles in the rest of the year included a digital electronics course and "How New FTC Hi-Fi Rules Affect You."

The world's first microcomputer kit to rival commercial models—the Altair 8800—was introduced on the cover of PE's January 1975 issue, with how-to-build plans detailed inside. This computer stunned the electronics world since its total price, including a beautiful enclosure, cost virtually the same as what its microprocessor—the powerful Intel 8800—was selling for at the time. It's commonly acknowledged that this milestone was the beginning of the home/very-small-business computer market. A myriad of "firsts" followed: the first low-cost all-solid-state TV camera, how to build a direct-drive single-play turntable, a programmable music box, and others. Also, Forrest Mims' popular "Experimenter's Corner" was initiated.

This creative publishing effort was carried through over the next few years with the introduction of construction plans for computer color graphics ("TV Dazzler"), a modem for data communications by telephone (The "Pennywhistle"), an all-in-one computer and terminal ("SOL"), the COSMAC "Elf," "Speechlab" computer voice communications, a low-cost logic analyzer, a Bucket Brigade audio delay system, Morse Code automatic alphanumeric-readout receiver, a computer chess game, etc., as well as feature coverage of new electronics products such as electronic games, video cassette tape recorders, home projection TV systems, car stereo, and video disk systems.

In keeping with the country's energy crisis, 1979 issues contained articles on building a 55-mph "Cruisealert," a "Low Fuel Warning Buzzer," and this issue's motor energy-saving device (developed by NASA), as well as advanced technology articles such as the recent "Upcoming New World of TV Reception," which clarified how the vertical interval can carry information for a variety of purposes.

Next month, you'll read about a solid-state humidity controller project that reduces heating fuel use, a Guide to Buying Printers for Computers, an RTTY Reader project, and more.

So as you can see, POPULAR ELECTRONICS has been an active participant in the startling electronics revolution that took place over the past quarter of a century, both as an information medium and as a "mover and shaker" of events by spearheading the introduction of new types of electronic equipment. We look forward to sharing future developments in electronics with you for the next 25 years, particularly since many of you have been (and will be) part of the continually growing electronics scene through writing articles, creating construction projects and sending us feedback letters.

Art Salsberg

POPULAR ELECTRONICS

328 WAYS TO INCREASE YOUR ELECTRONICS KNOW-HOW!

SEND NO MONEY! We'll invoice you on 10-DAY FREE TRIAL. ALL BOOKS 100% GUARANTEED. You must be satisfied or return the books and we'll cancel the invoice.

COMPUTERS, MICROPROCESSORS & ROBOTICS

- 1241—How To Build Your Own Self-Programming Robot 238 p. \$7.95
- 1062—The A to Z Book of Computer Games 308 p. 73 p. \$7.95
- 1111—Design, Build, Prog. Your Own Working Computer \$7.95
- 1053—Microprocessor Cookbook 266 p. 124 p. \$5.95
- 1141—How To Build Your Own Working Robot Pet 238 p. 85 p. \$6.95
- 1107—Computerist's Handy Manual 64 p. 39 p. \$2.95
- 1069—Computerist's Handy Databook/Dictionary 96 p. 42 p. \$3.95
- 1071—The Complete Handbook of Robotics 364 p. 137 p. \$7.95
- 1085—24 Tested, Ready-To-Run Game Programs in BASIC 252 p. \$5.95
- 1070—Digital Interfacing with an Analog World 406 p. 277 p. \$8.95
- 1088—Illustrated Dict. of Microcomputer Terminology 322 p. 150 p. \$7.95
- 1075—Artificial Intelligence 252 p. 118 p. \$7.95
- 841—Build Your Own Robot 238 p. 117 p. \$7.95
- 1099—How To Build Your Own Working 16-Bit Microcomputer 80p. \$3.95
- 1095—Programs in BASIC for Elec. Eng. Techs. & Exp. 140 p. \$4.95
- 1077—Hdbk. of Remote Control & Automation Techs. 294 p. 250 p. \$7.95
- 1055—The BASIC Cookbook 140 p. 49 p. \$4.95
- 1015—Beginner's Gde. to Computers & Microprocessors 308 p. \$6.95
- 1000—57 Practical Programs & Games in BASIC 210 p. \$4.95
- 995—Beginner's Guide to Microprocessors 182 p. 106 p. \$5.95
- 985—Programming Microprocessors 208 p. 102 p. \$6.95
- 676—Simplified Computer Programming—Including RPG 240 p. \$6.95
- 971—Miniprocessors: from Calculators to Computers 196 p. \$5.95
- 874—Master Handbook of Digital Logic Applics. 392 p. 287 p. \$7.95
- 952—Microprocessor Programming for Computer Hobbyists 387 p. \$7.95
- 955—Modern Digital Communications 308 p. 122 p. \$6.95
- 852—Piloting/Navigation With the Pocket Calculator 406 p. 338 p. \$8.95
- 975—The Computer Book—Build Super Calculators & Minicomputer Hdwe. with Calculator Chips 322 p. 227 p. \$7.95
- 752—Computer Programming Handbook 518 p. 114 p. \$9.95
- 554—Computer Technician's Handbook 480 p. 428 p. \$9.95
- 824—Advanced Applications for Pocket Calculators 304 p. 275 p. \$5.95
- 538—Computer Circuits & How They Work 192 p. 109 p. \$5.95
- 574—Beginner's Guide to Computer Programming 480 p. 364 p. \$9.95
- 785—Microprocessor/Microprogramming Hdbk. 294 p. 176 p. \$6.95
- 709—Modern Guide to Digital Logic 284 p. 222 p. \$7.95
- 724—Get the Most Out of Electronic Calculators 204 p. 28 p. \$4.95
- 548—Beginner's Guide to Computer Logic 192 p. 175 p. \$5.95

CIRCUITS BOOKS, HOBBY ELECTRONICS & PROJECTS

- 1123—The Laser Experimenter's Handbook 210 p. 187 p. \$6.95
- 1116—Making & Using Electricity from the Sun 144 p. 73 p. \$7.95
- 881—666 Science Tricks & Experiments 406 p. 386 p. \$7.95
- 1142—84 Practical IC Projects You Can Build 140 p. 113 p. \$4.95
- 805—99 Test Equipment Projects You Can Build 378 p. 337 p. \$7.95
- 804—Master Hdbk. of 1001 MORE Practical Electronic Circ. \$12.95
- 1105—How To Cast Small Metal & Rubber Parts 144 p. 132 p. \$5.95
- 1101—How To Design & Build Your Own Custom TV Games 546 p. \$9.95
- 805—The Power Supply Handbook 420 p. 232 p. \$7.95
- 1108—Lasers, The Light Fantastic 294 p. 158 p. \$7.95
- 1079—How To Build & Use Low-Cost Hydrophones 140 p. 98 p. \$4.95
- 1113—Understanding Electronics 182 p. 265 p. \$4.95
- 800—Master Hdbk. of 1001 Practical Electronic Circuits 602 p. \$9.95
- 1060—303 Dynamic Electronic Circuits 308 p. 303 p. \$6.95
- 1023—Beginner's Guide to Designing Cds, Transistor Radios 84 p. \$2.50
- 965—Modern Transistor Radios 64 p. 12 p. \$2.50
- 958—Beginner's Guide to Making Elec. Gadgets 140 p. 113 p. \$4.95
- 921—The ABC Book of Hi-Fi/Audio Projects 168 p. 131 p. \$4.95
- 909—How to Build Metal/Treasure Locators 140 p. 60 p. \$3.95
- 935—Build-It Book of Optoelectronic Projects 238 p. 175 p. \$5.95
- 30—Handbook of Optoelectronic Projects 444 p. 317 p. \$5.95
- 964—Modern Crystal Radios (Make and Use Series) 64 p. 101 p. \$2.50
- 637—Fun with Electronics 140 p. 50 p. \$3.95
- 936—Optoelectronics Guidebook—with Projects 196 p. 115 p. \$5.95
- 905—Build-It Book of Digital Electronic Timepieces 294 p. 209 p. \$6.95
- 926—Model Railroad Electronics 308 p. 218 p. \$5.95
- 912—88 Practical Op. Amp. Projects You Can Build 140 p. \$4.95
- 928—CBers' Handbook of Simple Hobby Projects 168 p. 114 p. \$4.95
- 987—106 Easy Elec. Projects beyond the transistor 224 p. \$5.95
- 780—21 Simple Transistor Radios You Can Build 140 p. 122 p. \$3.95
- 861—Display Electronics 252 p. 195 p. \$5.95
- 711—Integrated Circuits Guidebook 196 p. 119 p. \$5.95
- 667—Miniature Projects for Electronics Hobbyists 168 p. 77 p. \$3.95
- 708—Indrbdx. Guide to Modern Electronic Circuits 216 p. 92 p. \$4.95
- 787—OP AMP Circuit Design & Applications 280 p. 239 p. \$5.95
- 798—MOSFET Circuits Guidebook—with 100 Projects 322 p. 196 p. \$5.95
- 714—Radio Astronomy for the Amateur 252 p. 88 p. \$5.95
- 571—Radio Electronics Hobby Projects 192 p. 214 p. \$6.95
- 591—Solid State Projects for the Experimenter 224 p. 228 p. \$4.95
- 780—111 Digital Projects You Can Build 210 p. 244 p. \$4.95
- 699—Solid State Circuits Guidebook 252 p. 227 p. \$5.95
- 524—104 Easy Projects for Electronics Gadgets 160 p. 105 p. \$4.95
- 486—104 Simple One-Tube Projects 192 p. 104 p. \$3.95
- 228—Handbook of IC Circuit Projects 224 p. 136 p. \$5.95
- 487—64 Hobby Projects for Home & Car 192 p. 195 p. \$4.95
- 537—25 One-Tube Projects You Can Build 192 p. 125 p. \$4.95
- 83—Fun with Electricity 128 p. 94 p. \$3.95
- 647—Stereo Quad Hi-Fi Principles & Projects 192 p. 100 p. \$4.95
- 644—Electronic Hobbyist's IC Project Handbook 154 p. 86 p. \$4.95
- 613—New IC FET Principles & Projects 154 p. 60 p. \$4.95
- 462—104 Easy Transistor Projects You Can Build 224 p. 105 p. \$5.95
- 590—Practical Solid-State Principles & Projects 176 p. 127 p. \$3.95
- 568—IC Projects for Amateur & Experimenter 192 p. 252 p. \$5.95
- 422—Transistor Projects for Hobbyists & Students 192 p. 153 p. \$4.95
- 70—Electronic Puzzles & Games 128 p. 75 p. \$3.95

AUDIO, RECORDING, HI-FI & STEREO

- 1034—How To Select & Install Your Own Speakers 238 p. 131 p. \$5.95
- 1166—Build a Small Budget Recording Studio From Scratch \$8.95
- 867—Electrical Hdbk. for RVs, Campers, Vans, Boats, Trailers \$3.95
- 1001—Master Handbook of Still & Movie Titrating for Amateur & Pro \$9.95
- 911—How To Repair Movie & Slide Projectors 304 p. 270 p. \$7.95
- 912—Reasoning & Collecting Antique Reed Organs 320 p. 124 p. \$8.95
- 1064—How to Design & Build Your Own Complete Stereo Systems 336 p. \$9.95
- 1056—Install Everything Electr. in Cars/Boats/Planes/Trucks 364 p. \$7.95
- 1042—Jap Radio, Record/Tape Player Schem. Manual—V. 2 200 p. \$7.95
- 717—Understanding Sound, Video & Film Recording 140 p. 74 p. \$5.95
- 966—Complete Handbook of P.A. Sound Systems 272 p. 148 p. \$7.95
- 736—Amateur Filmmaker's Hdbk. Sound Sync/Scoring 210 p. \$5.95
- 575—Microphones—How Work & How to Use Them 224 p. 92 p. \$5.95
- 645—Acoustic Techniques for Home & Studio 224 p. 158 p. \$6.95
- 781—Handbook of Multichannel Recording 322 p. 196 p. \$7.95
- 934—Photo Guide to AM/FM Stereo Repair 288 p. 281 p. \$7.95
- 756—4-Channel Stereo From Source to Sound 252 p. 102 p. \$4.95
- 634—Basic Audio Systems 240 p. 203 p. \$4.95
- 1031—Produce Exciting Slide Shows & Movies With Sound \$8.95
- 689—Cassette Tape Recorders/How Work/Care/Repair 204 p. \$5.95
- 497—Tape Recording for Fun & Profit 224 p. 171 p. \$5.95
- 881—Questions & Answers About Tape Recording 264 p. 102 p. \$5.95
- 716—Servicing Cassette & Cartridge Tape Players 294 p. 196 p. \$5.95
- 505—Installing & Servicing Home Audio Systems 256 p. 136 p. \$5.95
- 67—Elementary Circuits 224 p. 145 p. \$3.95
- 642—Jap Radio, Record & Tape Player Service Manual 228 p. \$5.95
- 59—Servicing Record Changers 224 p. 173 p. \$5.95

BASIC & GENERAL ELECTRONICS TECHNOLOGY

- 510—How To Read Electronic Circuit Diagrams 192 p. 140 p. \$6.95
- 588—Basic Electronics Course 384 p. 275 p. \$9.95
- 828—Resistor Ignition Systems 252 p. 162 p. \$5.95
- 749—Auto Electronics Simplified 256 p. 202 p. \$5.95
- 748—The Complete Auto Electronic Handbook 210 p. 139 p. \$5.95
- 891—Practical Solid-State DC Power Supplies 186 p. 151 p. \$5.95
- 628—Basic Electricity & Beginning Electronics 252 p. 191 p. \$6.95
- 830—Introduction to Medical Electronics 320 p. 126 p. \$7.95
- 655—Modern Electronics Math 886 p. 424 p. \$11.95
- 728—Basic Digital Electronics 210 p. 117 p. \$4.95
- 691—Electronics Unraveled 228 p. 96 p. \$5.95
- 828—Switching Regulation & Power Supplies 252 p. 128 p. \$5.95
- 583—Industrial Electronics: Principles & Practice 416 p. 380 p. \$8.95
- 930—Servicing Medical & Bioelectronic Equipment 350 p. 165 p. \$8.95
- 300—Dictionary of Electronics 420 p. 487 p. \$5.95
- 601—Basic Color Television Course 420 p. over 300 p. \$9.95
- 104—Basic Radio Course 224 p. 128 p. \$5.95
- 838—Marine Electronics Handbook 32 p. 105 p. \$4.95
- 628—Pulse & Switching Circuits—256 p. 184 p. \$5.95
- 585—Digital Electronics: Principles & Practice 292 p. 191 p. \$5.95
- 105—Basic TV Course 224 p. 128 p. \$5.95
- 111—Basic Transistor Course—224 p. 179 p. \$5.95
- 791—Mathematics Unraveled—A New Commonsense Approach \$6.95

ELECTRONIC TEST EQUIPMENT

- 132—How To Test Almost Everything Electronic 160 p. 144 p. \$3.95
- 730—Effective Troubleshooting with EVM/Scope 238 p. 185 p. \$5.95
- 1012—How To Design, Build & Power Test Equipment 420 p. 210 p. \$9.95
- 792—Build-It Book of Miniature Test & Meas. Instr. 238 p. 151 p. \$4.95
- 422—Working with the Oscilloscope 140 p. 183 p. 7" x 9" \$4.95
- 672—Understanding & Using the VOM & EVM 192 p. 187 p. \$5.95
- 927—How to Use AF & RF Signal Generators 238 p. 162 p. \$5.95
- 702—Electronic Measurements Simplified 240 p. 214 p. \$4.95
- 723—Electronic Test Equipment—A How To Use It 204 p. 174 p. \$5.95
- 729—RF & Digital Test Equipment You Can Build 252 p. 217 p. \$5.95
- 877—Under & Using Modern Signal Generators 294 p. 120 p. \$5.95
- 664—Understanding & Using the Oscilloscope 272 p. 170 p. \$5.95
- 577—How to Use Color TV Test Instruments 256 p. 230 p. \$5.95
- 131—Test Instruments for Electronics 192 p. 155 p. \$4.95
- 880—How To T-Shoot & Repair Electr. Test Equip. 252 p. 143 p. \$6.95
- 777—Under/Using Modern Electr. Servicing Test Equipment 252 p. \$5.95
- 483—99 Ways to Use Your Oscilloscope 192 p. 327 p. \$5.95
- 485—How to Use Test Instr. in Electronics Servicing 256 p. 234 p. \$4.95

APPLIANCES, ELECTRICITY & ENERGY

- 925—Practical Electrical Installation, Repair & Rewiring 408 p. \$7.95
- 1178—How To Make Your Own Solar Electricity 68 p. 87 p. \$5.95
- 1020—Auto Air Conditioning Handbook—Install, Maint. & Repair \$6.95
- 1176—The Master Handbook of ALL Home Heating Systems 352 p. \$7.95
- 631—Aviation Electronics Handbook 408 p. 227 p. \$8.95
- 128—Make Home Electricity From Wind, Water & Sunshine \$5.95
- 1019—The Master Handbook of Electrical Wiring 408 p. 289 p. \$6.95
- 1036—Cut Your Electric Bill—Install Your Own Emergency Power Sys. \$2.95
- 1063—How To Install Your Own Home or Mobile Ele. Power Plant \$5.95
- 931—Direct Current Motors 252 p. 170 p. \$14.95
- 987—Hearing Aid Handbook 336 p. 224 p. \$8.95
- 913—Complete Hdbk. of Electrical & House Wiring 476 p. 183 p. \$6.95
- 906—Homeowner's Gde. to Solar Heating/Cooling 196 p. 113 p. \$4.95
- 962—Microwave Oven Service & Repair 420 p. 210 p. \$9.95
- 903—Guide to Modern Energy-Efficient Heating/Cooling Sys. \$5.95
- 758—How To Completely Secure Your Home 224 p. 162 p. \$5.95
- 1030—301 Practical Uses for Propane Torches 140 p. 98 p. \$3.95
- 1006—Build-It Book of Solar Heating Projects 196 p. 111 p. \$4.95
- 820—Central Heating Air, Coal, Radiator Guide 320 p. 285 p. \$6.95
- 797—Electric Motor Test & Repair 160 p. 102 p. \$5.95
- 515—Small Appliance Repair Guide—Vol. 1 224 p. 100 p. \$5.95
- 917—How To Repair Small Gasoline Engines 392 p. 251 p. \$6.95
- 1040—Homeowner's Guide to Saving Energy 288 p. 183 p. \$5.95
- 745—The Home Appliance Clinic 196 p. 61 p. \$4.95
- 885—How to Repair Home Kitchen Appliances 294 p. 205 p. \$5.95
- 920—Complete Hdbk. of Locks & Locksmithing 392 p. 200 p. \$6.95
- 855—How to Repair Home Laundry Appliances 280 p. 137 p. \$5.95
- 715—Small Appliance Repair Guide—Vol. 2 210 p. 119 p. \$4.95
- 555—Major Appliance Repair Guide 288 p. 278 p. \$5.95
- 671—Electrician's Handbook for Home & Office 204 p. 155 p. \$4.95
- 520—How to Repair Home & Auto Air Conditioners 208 p. 100 p. \$5.95
- 295—Refrigeration 160 p. 53 p. \$3.95

FCC LICENSE STUDY GUIDES

- 1073—Amateur Rad Lic. Sly Gde. for Nov Tech. & Gun Class \$6.95
- 1092—First Class Commercial FCC Lic. Study Guide 392 p. 205 p. \$7.95
- 582—Commercial FCC License Handbook 444 p. 150 p. \$7.95
- 652—2nd Class FCC Encyclopedia Study Guide 602 p. 600 p. \$7.95
- 893—Third Class FCC License Study Guide 322 p. 88 p. \$6.95
- 873—Ham Radio Novice Class License Study Guide 240 p. 57 p. \$5.95
- 851—Ham Radio General Class License Study Guide 448 p. \$7.95
- 827—Ham Radio Advanced Class License Study Guide 252 p. \$5.95
- 943—Ham Radio Extra Class License Study Guide 224 p. 162 p. \$5.95
- 989—Ham Radio Incentive Licensing Guide 154 p. 34 p. \$4.95

CB COMMUNICATIONS, HAM RADIO & PHONES

- 1152—Antenna Data Reference Manual—including dimension tables \$7.95
- 1120—OSCAR The Ham Radio Satellites 128 p. 95 p. \$4.95
- 802—The Giant Book of Amateur Radio Antennas 462 p. 255 p. \$8.95
- 999—How to Hear & Speak CB In a Short-Short 176 p. \$3.50
- 665—Mobile Radio Handbook 192 p. 170 p. \$3.50
- 1097—All About Telephones 192 p. 140 p. \$4.95
- 1052—Radio Detector Handy Manual 82 p. 63 p. \$4.95
- 1054—Antenna Construction Hdbk. for Ham, CB & SWL 238 p. \$5.95
- 1005—Hdbk. of Solar Flare Monitoring & Prop. Forecasting 196 p. \$6.95
- 997—The Handbook of Telephones & Accessories 432 p. 215 p. \$9.95
- 969—CBers' Handy Manual of Base Stations 96 p. 55 p. \$2.50
- 801—Master Handbook of Ham Radio Circuits 392 p. 301 p. \$8.95
- 958—Home-Brew HF/VHF Antenna Handbook 210 p. 143 p. \$5.95
- 959—CB & Handy Manual of SCS 80 p. \$2.50
- 621—The Complete Shortwave Listener's Handbook 288 p. 101 p. \$6.95
- 683—Pictorial Guide to CB Radio Install./Repair 256 p. 304 p. \$5.95
- 673—How to Be a Ham—Includes Latest FCC Rules 192 p. 25 p. \$3.95
- 1056—III Dict. of Broadcast—CATV—Telecoms 420 p. 104 p. \$8.95
- 799—CB Radio Operator's Guide—2nd Edition 256 p. 139 p. \$5.95
- 809—Ham Radio Handy Manual of SCS 80 p. \$2.50
- 735—The Complete FM 2-Way Radio Handbook 294 p. 111 p. \$5.95
- 859—The Complete Handbook of Slow-Scan TV 304 p. 169 p. \$9.95
- 954—Practical CB Radio Troubleshooting & Repair 406 p. 169 p. \$7.95
- 997—RTTY Handbook 320 p. 230 p. \$5.95
- 933—CBers' Handy Manual of SCS 80 p. \$2.50
- 712—Amateur FM Conversion & Const. Projects 276 p. 187 p. \$5.95
- 678—Modern Communications Switching Systems 276 p. 171 p. \$17.95
- 881—Citizens Band Radio Service Manual 228 p. 84 p. \$5.95
- 621—The 2-Meter FM Repeater Circuits Handbook 312 p. 194 p. \$6.95

ENGINEERING & REFERENCE

- 1133—The Active Filter Handbook 280 p. 251 p. \$6.95
- 1132—Hdbk. of Electrical Noise: Measurement and Technology \$6.95
- 1035—Electronic Designer's Handbook—3rd Edition 350 p. 278 p. \$9.95
- 1087—How to Read Blueprints & Station Engineers 182 p. 135 p. \$4.95
- 1038—Instrumentation & Control Sys. Eng. Hdbk. 434 p. 184 p. \$19.95
- 929—Solid-State Motor Controls 322 p. 162 p. \$7.95
- 742—Prof. Electrical/Electr. Engrs. License Study Guide 476 p. \$7.95
- 750—Electronic Conversions, Symbols & Formulas 224 p. 46 p. \$5.95
- 829—Impedance 196 p. 90 p. \$5.95
- 934—Digital Electronic Handbook 308 p. 225 p. \$5.95
- 118—Electronics Data Handbook 256 p. 149 p. \$5.95
- 101—Electronic Circuit Design Hdbk.—4th Edition 416 p. 968 p. \$19.95

SEMICONDUCTORS, TUBES & TRANSISTORS

- 1216—Towers International OpAmp Linear-IC Selector 190 p. \$7.95
- 1100—Master Transistor/IC/Diode Substitution Hdbk.—2nd Ed. \$11.95
- 1016—Towers International FET Selector 140 p. 97 p. \$4.95
- 1010—Towers Intern. Transistor Selector 200 p. 179 p. 7" x 10" \$6.95
- 856—Master OP-AMP Applications Handbook 476 p. 320 p. \$9.95
- 980—IC Function Locator 224 p. 28 p. \$5.95
- 984—CMOS Databook 280 p. 270 p. \$5.95
- 870—Master Tube Substitution Handbook 322 p. 576 p. \$4.95
- 717—Transistor Theory for Technicians & Engrs. 224 p. 116 p. \$5.95
- 938—Linear IC Applications Handbook 280 p. 183 p. \$5.95
- 1074—Transistor Circuit Guidebook 224 p. 118 p. \$5.95
- 984—Microelectronic 266 p. 229 p. \$5.95
- 708—Modern Applications of Linear ICs 276 p. 301 p. \$5.95
- 116—Getting Started with Transistors 160 p. 90 p. \$3.95

ELECTRONIC MUSIC

- 743—Electronic Music Circuit Guidebook 252 p. 180 p. \$6.95
- 843—Sourcebook of Electronic Organ Circuits 168 p. 101 p. \$4.95
- 718—Electronic Music Production 156 p. 79 p. \$3.95
- 666—Experimenting with Electronic Music 180 p. 103 p. \$4.95
- 548—Electronic Musical Instruments 192 p. 121 p. \$5.95
- 843—Electronic Musical Instr. Manual 210 p. 7" x 10" 385 p. \$8.95
- 503—Servicing Electronic Organs 196 p. 8" x 11" 145 p. \$9.95

TV, RADIO & ELECTRONIC SERVICING

- 1131—Beginner's Guide to TV Repair—2nd Edition 224 p. 56 p. \$5.95
- 1082—TV Field & Bench Services Handbook 208 p. 185 p. \$6.95
- 1119—Color TV Trouble Factbook—4th Edition 434 p. 100 p. \$7.95
- 1028—How To Repair Video Games 270 p. 182 p. \$7.95
- 939—Hdbk. of Marine Electronic & Electrical Systems 546 p. \$9.95
- 921—CEI TV Troubleshooting—2nd Edition 448 p. 381 p. \$9.95
- 821—TV Troubleshooting with the Dual-Trace Scope 224 p. 252 p. \$5.95
- 563—Beginner's Guide to TV Repair 176 p. 50 p. \$4.95
- 956—Fire & Theft Security Systems—2nd Ed. 192 p. 108 p. \$5.95
- 746—Color TV Case Histories Illustrated—Vol. 2 352 p. 243 p. \$7.95
- 746—Color TV Case Histories Illustrated—Vol. 3 218 p. \$5.95
- 798—Photo Symptom Guide: Solid-State Color TV Troub. 224 p. \$5.95
- 772—Troubleshooting with the Dual-Trace Scope 224 p. 252 p. \$5.95
- 739—TV Schematics: Reading Between the Lines 252 p. 158 p. \$5.95
- 605—Install./Servicing Electr. Protective Systems 252 p. over 160 p. \$5.95
- 696—TV Tuner Schematic Servicing Manual—Vol. 1 224 p. 287 p. \$6.95
- 979—TV Tuner Schematic Servicing Manual—Vol. 2 200 p. 374 p. \$6.95
- 690—Logical Color TV Troubleshooting 240 p. 151 p. \$5.95
- 598—Dog Problems Solved 252 p. 199 p. \$5.95
- 580—Modern Radio Repair Techniques 260 p. 207 p. \$5.95
- 532—How to Repair Solid-State Imports 192 p. 8" x 11" 122 p. \$7.95
- 484—TV Servicing Guidebook: Problems & Solutions 176 p. 110 p. \$4.95
- 761—Jack Darr's Service Clinic No. 3 252 p. 122 p. \$4.95
- 133—Jack Darr's Service Clinic No. 1 192 p. 125 p. \$4.95
- 921—Color TV Troubleshooting—12 Minutes 492 p. 243 p. \$6.95
- 595—192 Color TV Troubles & Solutions 224 p. 178 p. \$5.95
- 507—101 TV Troubles—From Symptom to Repair 224 p. 170 p. \$6.95
- 619—Shooting Solid-State Electr. Power Supplies 208 p. 85 p. \$4.95
- 778—Small-Screen TV Servicing Manual 240 p. 367 p. \$6.95
- 633—Shooting Solid-State Wave Gen. & Shaping Circs. 92 p. \$4.95
- 626—Install. TV & FM Antennas 168 p. 158 p. \$4.95
- 835—VHF/UHF Fire, Police, Ham Scanners Ser. Manual 250 p. \$6.95
- 625—Troubleshooting Solid-State Amplifiers 256 p. 95 p. \$4.95
- 732—Jap Consumer Electr. Ser. Man. 196 p. incl. schematic/old \$5.95
- 694—Auto Stereo Service & Installation 252 p. 245 p. \$5.95

MODEL RADIO CONTROL

- 1093—Radio Control Handbook—4th Edition 420 p. 315 p. \$9.95
- 1135—Radio Control Manual—Sys., Circuits, Const.—3rd Ed. \$5.95
- 825—Flying Model Airplanes/Helicopters for RC 192 p. 147 p. \$5.95
- 847—RC Handbook of Model Airplane & Helicopters 196 p. 143 p. \$5.95
- 1142—Radio Control for Models 350 p. 417 p. \$5.95
- 693—Model Sail & Power Boats by Remote Control 192 p. 125 p. \$4.95
- 122—Advanced Radio Control 192 p. 181 p. \$5.95

BROADCAST, CATV, CCTV & VIDEOTAPE

- 890—Analysis of Local Radio-TV Copy-4th Ed. 140 p. \$5.95
- 865—CATV Program Origination & Production 256 p. 64 p. \$14.95
- 811—Complete Hdbk. of Videocassette Recorders 280 p. 160 p. \$5.95
- 825—Broadcast Eng. & Maintenance Hdbk. 332 p. \$19.95
- 815—Design Maintn. CATV/Small TV Studio 288 p. 100 p. \$12.95
- 779—Music Scoring for TV & Motion Pictures 256 p. 166 p. \$12.95
- 666—Broadcasting Production Handbook 210 p. 44 p. \$12.95
- 755—Color TV Studio Design & Operation 168 p. 69 p. \$9.95
- 1099—CCTV Installation, Maintenance & Repair 284 p. 208 p. \$5.95
- 733—Talk-Back TV Two-Way Cable Television 228 p. 64 p. \$5.95
- 835—Complete Broadcast Antenna Handbook 448 p. 310 p. \$17.95</

Letters

PE BACK ISSUES NEEDED

I recently had a fire in my house and garage and all of my early issues of **POPULAR ELECTRONICS**, from Volume 1 No. 1 through

1972, were destroyed. I would greatly appreciate it if you could forward information as to where I can obtain replacements.—*Thomas D. Laase, 9 Hadley Hill, Pueblo, CO 81001.*

Perhaps one of our readers has a set he's willing to part with. If so, please contact Mr. Laase directly at the address given.

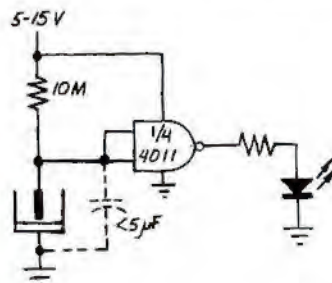
VOLTAGE SPIKE PROTECTION

Having built the "Automatic Garage Door Closer" (March 1979), I would like to call your attention to one problem. There is no diode across the relay's coil to protect the transistor from voltage spikes. After burning out a couple of transistors, I installed a 1N4004 rectifier diode across K1's coil. Now the circuit op-

erates just fine. Thanks for a useful project.—*Glen Charnock, WB6JKM, Oxnard, CA.*

ALTERNATE METHOD

I enjoyed "Space-Age Electronic Projects for Boats" (July and August 1979) and would like to share a simpler way to detect high liquid levels. The circuit is shown here. Any CMOS inverter or inverting gate can be used. If a hex inverter were used, you could have six detectors per IC. So, using this scheme



for the fresh-water tank gauge would eliminate three ICs, nine capacitors, and three transistors. An electrolytic capacitor of 5 µF or less will eliminate LED flashing when the liquid in the tank sloshes.

CMOS level detectors will even work in demineralized water, where the LM1830 will not. They will also work on unrectified AC power, which should eliminate any tendency for the electrodes to electroplate. If the tank is nonconductive, a ground probe must be used in the liquid.—*Clyde Hyde, Tenino, WA.*

TEST RECORD EXPLANATION

In the July "Stereo Scene," Ralph Hodges refers to the Soundcraftsmen Test Record, with a brief explanation of its content and application. That description was incomplete and actually incorrect. The test tones on the record are clearly specified to be all at the same level—there is no roll off or compensation at top and bottom. The Test Record can be used correctly with a sound-level meter. Only the 1-kHz Reference Tones, designed specifically for "listening EQ," are Fletcher-Munson compensated and they appear only on the opposite channel, designed so that the EQ process also compensates for the user's hearing idiosyncracies.

As a further aid in the equalization process, the Test Record also contains all-band pink noise to be used with any further instrumentation the consumer wishes to utilize for his own purposes. The test instructions clearly explain these methods.—*Ralph F. Yeomans, President, Soundcraftsmen, Santa Ana, CA.*

When you're into electronics, Calctro is into whatever you need — whether it's ideas, instructions, or a complete supply of parts

Calctro has projects designed for you: a "Project of the Month", conceived by the Calctro engineering department, along with detailed instructions and a list of all the Calctro parts you need to build it!



Calctro has parts and accessories: printed circuit materials, tools, meters, testing devices, equipment boxes, sockets, switches, IC's, transistors, rectifiers, lugs, fuses, bulbs, wire, connectors, terminals, jacks, transformers, and lots more — everything you need to complete your project. And you'll find more of the parts you want at your Calctro store than anywhere else.



Calctro has literature: the Calctro Handbook — a valuable guide and product reference for the experimenter, hobbyist, audiophile, technician, and student; plus handbooks on semiconductors, circuits, and more! Coming soon: a new Calctro Handbook, a compendium of popular project ideas.

Whatever you need in electronics, your Calctro distributor is your surest, finest source!



Calctro

Products of GC Electronics, Rockford, IL 61101

Out of Tune

In "Build an In-Circuit Transistor Tester for \$10," p. 54, July 1979, there is an omission in the schematic diagram (Fig. 1). The RESET input of IC2, a 4027 CMOS flip-flop, must be connected to V_{SS} if the circuit is to operate properly. This can be accomplished by connecting pin 12 to pins 3 through 9.



Genius Offspring

"Its successor, the new Chess Challenger '7', is infinitely more powerful."

—S. Samole

President, Fidelity Electronics

Chess Challenger-10 did more than win the Penrod Memorial Microchess Tournament, it literally trounced all opponents. Personal Computing Magazine, February, 1979, reports, "Chess Challenger-10 emerged as the easy victor with ten wins, two draws and no losses."

All Top Name Performers

There were no amateurs in the championship playoff. Every contender bore the brand of a well-known electronic chess game, and each was accompanied by its entourage of coaches, programmers, and engineers. After each contestant had played all of the opponents in round robin fashion, the brilliant Challenger-10, stood far ahead of its second place runner-up.

Nobody Knew

Unknown to the other companies, the undefeated tournament leader was being retired after the contest. Taking its place was a far more powerful chess computer, the Challenger "7." This new micro-computer had already beaten the official undefeated champ during a series of pre-tournament warm-up games at the factory. Its engineers explain that it is simply 14 months ahead in technology, in finer algorithm sophistication and in its superb performance.

Improve Your Game to Near Brilliant

Within its seven different levels of play, you can enjoy every degree of chess competition, from beginner to tournament skill. Its

total flexibility lets you change games mid-stream or switch sides with the computer to see how it would handle your dilemma. You can add pieces to your side or take away the computer's Queen. It is a superb teacher!

Touch the PV key and the "7's" total recall memory will verify every piece position on the board. You can even set up hypothetical encounters to test its reaction at each level.

Fidelity's Challenger "7" is able to analyze over 3,024,000 board positions. It masterfully handles over one thousand book openings and will respond to any deviation. Academic openings as Sicilian, French, Ruy Lopez and Queen Gambit Declined, are just some of the challenges to keep you on your toes.

It Knows Every Rule in the Book

The Challenger "7" will permit you to castle or perform an En Passant capture or do so itself, if that is its best move. When your pawn has reached the eighth rank, it will be automatically raised to a Queen, unless you tell the computer to promote it to another piece. It will take on any player and sharpen his skills considerably...but it won't permit illegal moves.

Sound Signals

You just cannot believe the chess I.Q. of this phenomenal unit. The Challenger "7" has a beep audio feedback which sounds to acknowledge your move, and double beeps when the computer has made its response.

At Level 1, its average response time is 5 seconds. At Tournament Level 7, the Challenger makes championship decisions in just 3 minutes.

Unbeatable in Price As Well As Play

Best of all, the Chess Challenger "7" is the most affordable electronic unit you can own. It is just \$89.95 complete with Staunton designed pieces and UL approved 110V AC adaptor.

All pieces are magnetized, to stay where you place them on the permanent metal board. The set is mounted in a simulated wood-grained housing which measures 12 1/2" x 8" x 1". Bright, one-half inch tall LED electronic digits, provide unmistakably clear readout. The unit is backed by a 90-day manufacturer's limited parts and labor warranty.

Enjoy It for 10 Days—At Our Expense

As a gift or for yourself, the "7" is unquestionably the finest chess computer you can select...but, if within 10 days, you are not satisfied, simply return it for a prompt, no-questions-asked refund.

CREDIT CARD ORDERS CALL TOLL FREE

800-621-5809

ILLINOIS RES: 800-972-5858
24 HOURS—7 DAYS/WEEK

Final Results

Reprinted Courtesy of Personal Computing, February, 1979. P. 66. (Darker lines ours.)

CONTESTANTS		OPPONENTS									Games Won	Games Drawn	FINAL SCORE	POSITION
		#1	2	3	4	5	6	7	8	9				
1	MICRO-CHESS 1.0 (Heath H-8)	W	X	1/2	0	1	0	0	0		1	3	8	2%
		B		1/2	0	0	0	0	0					7*
2	MICRO-CHESS 1.5 (TRS-80)	W	1/2	X	1/2	1/2	0	0	0		0	5	7	2%
		B	1/2		0	0	0	1/2	0					6*
3	MICRO-CHESS 2.0 (PET)	W	1/2	1	X	1	0	0	1/2		3	4	5	4
		B	1	1/2		1/2	0	0	0					
4	CHESS CHALLENGER (3 Level)	W	1	1	1/2	X	0	1/2	1/2		2	5	5	4%
		B	0	1/2	0		0	0	1/2					5
5	CHESS CHALLENGER (10 Level)	W	1	1	1	1	X	1	1/2		10	2	0	11
		B	1	1	1	1		1	1/2					1
6	BORIS	W	1	1/2	1	1	0	X	1		7	2	3	8
		B	1	1	1	1/2	0		0					3
7	SARGON I (TRS-80)	W	1	1	1	1/2	1/2	1	X		6	5	1	8%
		B	1	1	1/2	1/2	1/2	0						2
8	ATARI Did not play	W								X				
		B												

* Note: Microchess 1.5 wins 6th place over Microchess 1.0 by virtue of the tie breaking analysis of relative strength of opponents

Please send me _____ Chess Challenger "7(s)" at \$89.95 plus \$3.00 for shipping and insurance. Ill. residents add 5% sales tax. If not satisfied, I can return it within 10 days for a refund.

☐ Enclosed please find check or money order.
☐ Charge My Credit Card:
☐ American Express ☐ Master Charge ☐ Carte
☐ BankAmericard/Visa ☐ Diners Club ☐ Blanche

Credit Card No. _____

Master Charge # _____ Exp. Date _____

Name _____

Address _____

City _____

State _____ Zip _____

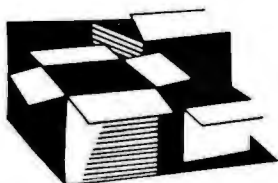
Signature _____

PE10 Camelot 79

Camelot
DIRECT

801 Green Bay Rd., Lake Bluff, IL 60044

A DIVISION OF UNITED EDUCATORS, INC.



New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

Hitachi Microprocessor Turntable

The top model of Hitachi's new turntable line is the HT-860. It uses a Uni-Torque di-



rect-drive motor with quartz-locked speed regulation and features fully automatic operation under control of a microprocessor. A photoelectric sensor indexes the tone-arm for records of various sizes, and fine-speed control for correction of musical pitch is provided. Operation is by means of front-panel electronic touch controls. Digital readout of speed and disc size is also included. Wow and flutter is rated at 0.025% wrms and S/N at 78 dB DIN B. \$800.

CIRCLE NO. 89 ON FREE INFORMATION CARD

Communication Microphone

The Model 526T Series II Super Punch[®] microphone from Shure can be used with transmitters and transceivers with 500 ohms or greater input impedance. It has a six-conductor coiled cord and a triple-pole, double-throw switch arranged for compatibility with most transceivers. The microphone's dynamic element is backed up by a preamplifier with volume control. The transmit/receive switch can be locked in the closed position. This same switch permits connection of speech processors, antenna relays, on-the-air lights, and other

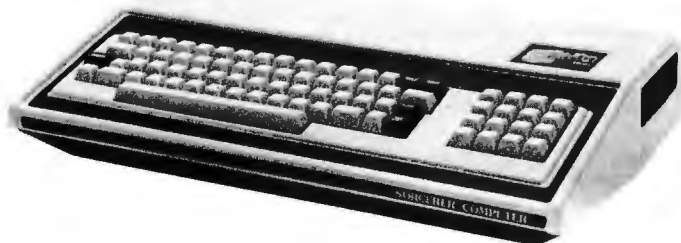


accessories. The microphone is housed in a tough plastic case that provides full shielding to minimize hum pickup and r-f interference. \$58.32.

CIRCLE NO. 91 ON FREE INFORMATION CARD

3½-Digit LCD DMM

Fluke's 8022A handheld 3½-digit DMM features an LCD display, automatic negative-polarity indication, and 24 measurement ranges for dc and ac volts, dc and ac current, and resistance with rated dc accuracy of $\pm 0.25\%$. Also, its case is a high-impact type. It is rated to withstand overloads up to 500 V on resistance ranges, 1000 V on voltage ranges, 2 A on current ranges, and voltage transients up to 6 kV.



For A Demonstration Or Further Information Contact Your Local Computer Store.

Exidy
inc.

#1



Finger guards on the test probes offer the user protection against accidental contact with high voltages. A 9-V battery powers the instrument for up to 150 hours; an LCD indicator activates when 20 hours of battery life remains. \$129.

CIRCLE NO. 92 ON FREE INFORMATION CARD



and has three presets for instant station switching. Bass and treble controls with center detents, a volume control with 21 detents, and a 10-LED power-output indicator are found in the preamp. The system includes a plug-in power amp (30 watts per channel into 4 ohms at 0.5% THD, 20-20,000 Hz) that can be installed in a hidden location.

CIRCLE NO. 93 ON FREE INFORMATION CARD

The computer, which uses two 8-inch floppy disks, offers a full keyboard, BASIC programming language, a video display (with high-resolution graphics) that handles up to 2K characters and 16 colors, audio output, a D/A converter for voice and music, joystick interfaces, and a large software library. In addition, an ac control interface allows power lines to be used as a route for control signals. Using an optional telephone interface, the system can dial telephone number and communicate via voice, touch-tone signals, or conventional modem signals at a 300-baud rate. \$2,597.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Futuristic Car Audio

"Cockpit," introduced by Panasonic, is a ceiling-mounted control unit for a car audio system. Included in the package are an auto-reverse cassette player with normal/CrO₂ tape selection and Dolby, an FM stereo tuner, and a preamp. The FM section, said to be highly sensitive, includes an automatic multipath noise suppressor

Versatile Home Computer

Ohio Scientific has unveiled the C8P DF, dubbed "Home Computer of the Future."



Low-Cost Cordless Telephone

Mura Corp.'s recently introduced "Mura-phone" is a cordless telephone system



	TEXAS EXIDY SORCERER	INSTRUMENTS 99/4	ATARI 800	APPLE II	COMPUCOLOR MOD III	COMMODORE PET	TANDY TRS-80
* FEATURES							
Price of Minimum Configuration	\$995	\$1150	\$999.99	\$1150	\$1495	\$795	\$599
Computer Type	Z80	9900	6502	6502	8080	6502	Z80
Maximum RAM in Unit	48K	16K	49.1K	48K	32K	8K	16K
ROM Supplied	12K	26K	16K	8K	17K	14K	4K
Display	B/W	Color	Color	Color	Color	B/W	B/W
CHAR/Line	64	32	40	40	64	40	64/32
Line/Screen	30	24	24	24	16/32	25	16
Graphic Resolution	512/240	192/256	380/192	280/192	128/128	320/200	128/48
Keyboard	79 Key Typewriter	40 Key Calculator	57 Key Typewriter	52 Key Typewriter	77 Key Typewriter	73 Key Calculator	53 Key Typewriter
Lower Case Standard	Yes	No	No	No	No	No	No
Numeric Keypad Standard	Yes	No	No	No	Yes	Yes	No
Programmable Characters Standard	128	No	No	No	No	No	No
I/O Electronics Included	Dual Cassette RS232 Communications 8 Bit Parallel	Joystick Sound	Joystick Serial Single Cassette	Single Cassette Joystick	Single Disk RS232 Communication	Single Cassette IEEE 488	Single Cassette
Expansion Bus	S-100	No	No	Yes	Yes	IEEE 488 Daisy Chain	Yes
Disk Available	630K Byte	No	92K Byte	116K Byte	51.2K Byte	125K Byte	45K Byte
System Software Available	ROM Basic ROM Assembler ROM Word Processor CPM EXT. Basic CPM Fortran CPM Cobol CPM APL CPM Pascal	ROM Basic	ROM Basic ROM Assembler	ROM Basic Disk Basic Pascal	Disk Basic	ROM Basic Disk Basic	ROM Basic Disk Basic Cassette Assembler

*Prices and specifications available June 1979.

390 Java Ave. Sunnyvale CA. 94086 (408) 734-9410

There is only one real pioneer It's Sony.



1957:
The world's first pocket transistor radio.

In 1954, a fledgling Japanese tape recorder manufacturer visited America to investigate a new device called the transistor.

At first, things were less than encouraging.

"Transistors are only good for hearing aids," they were told. "And besides, they can't be mass produced."

Undeterred, the Japanese representatives returned to Tokyo.

Thirty-six months later, the world saw its first pocket transistor radio.

Followed by the world's first all-transistor FM radio.

And, partially as a sign of their continuing dedication to audio, the Tokyo Telecommunications Engineering Corporation adapted the Latin word for sound—"sonus"—and changed its name to Sony.

In the years that have followed, Sony has never faltered in its dedication to technological innovation. And we'd be loathe to estimate how often our advances have ended up on the circuit boards and front panels of our competitors' equipment as "technological breakthroughs."

But enough of the past.

The hi-fi components featured here stand as eloquent proof that Sony—the

company that virtually founded the era of transistorized high fidelity—is still at its very forefront.

The V5 receiver:

To this day, only Sony offers Sony quality.

Unlike hi-fi receivers designed to impress you with a facade of magic buttons and switches, Sony receivers are designed to impress you with rich sound.

Case in point: the V5.

In technical terms, the V5 delivers 85 watts per channel at 8 ohms from 20 to 20,000 hertz with no more than 0.07% total harmonic distortion.

In human terms, this means the receiver can reproduce every note of music any instrument can play with no audible distortion. And it can power two sets of speakers without straining.

But that's only the beginning.

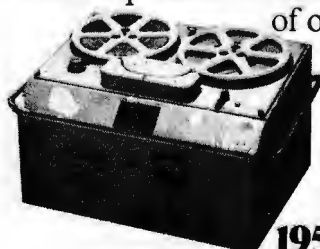
Instead of using the mundane power transformers found in competitors' products, the V5 utilizes more expensive toroidal core transformers that provide richer bass.

A few Sony Audio firsts:

- 1949:** Obtained patent on the basic magnetic tape-recording system.
- 1952:** Developed stereo broadcasting in Japan.
- 1954:** Introduced condenser microphone.
- 1955:** First consumer stereo tape recorder in Japan.
- 1959:** Invented "Tunnel Diode"; basis of all high-speed, low-distortion semiconductor.
- 1965:** First all-silicon solid state amplifier.
- 1966:** The first servo-controlled turntable. Forerunner of quartz-locked turntables.
- 1968:** First electronic end of record sensor.
- 1969:** First digital-synthesized FM tuner.
- 1969:** Invented the ferrite tape head.
- 1973:** Invented the V-FET: Opened era of high-speed transistors.
- 1973:** First to manufacture ferrichrome tape.
- 1973:** Dr. Esaki wins Nobel Prize in Physics for "Tunnel Diode."
- 1975:** First turntable with carbon-fiber tone arm.
- 1977:** The world's first consumer digital audio processor.
- 1977:** First consumer amplifier with pulse power supply.
- 1978:** Patented liquid crystal recording meters.

1954:
The first Japanese transistor.

1950: Japan's first tape recorder, the "Type G."



1979: The V5 receiver: Designed for people who appreciate value as much as they appreciate sound.

in high fidelity.



Instead of cutting corners by using a flimsy pressboard bottom, we've cut interference by encasing the *entire* receiver in metal.

And for better FM reception, instead of using the standard three- or four-gang variable-tuning capacitor, we've opted for a higher quality five-gang model.

All of which explains why if you pay a few dollars less for one of our competitors' receivers, it's probably because you're getting less receiver.

The new Sony cassette decks: The state of the art, from the people who invented it.

Since we introduced tape recording to Japan in 1950, Sony has sold millions of tape decks.

A quick look at our new TC-K65 cassette deck will explain why.

Like all two-motor cassette decks, the TC-K65 is designed for low wow and flutter. Unlike others, however, we feature "brushless and slotless" motors that reduce this problem to the point of being inaudible.

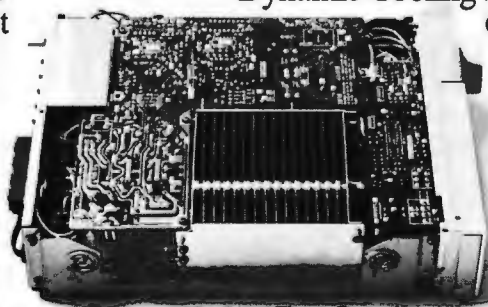
Instead of using just any tape head material, the TC-K65 features Sony "Sendust and Ferrite" heads that combine wide response with extreme durability.

Instead of using an ordinary metering system, we've developed a 16-segment LED meter whose life expectancy far exceeds the fancy blue fluorescent models other companies are currently touting.

And there's also a "Random Music Sensor" for preprogramming tapes, settings for metal



1979: The new TC-K65.
Sony remains one of the only hi-fi companies to produce our own tape transports, motors, meters, heads—even the tape itself.



1979: The Sony "ThermoDynamic Cooling System." Until now, only available in satellites.

1979:
The new TA-F40 integrated amplifier and ST-J60 digital synthesized FM tuner. Separate components that sound as sophisticated as they look.

tape, remote control and timer capabilities, and the kind of high-quality D.C. tape head amplifier you'll find in almost no one else's tape decks.

But you really haven't heard anything yet.

Unfortunately, we don't have enough space here to tell you the complete Sony hi-fi story.

Like the way a recent dealer survey rated our turntables #1 in value and performance.

Or the way our new separate tuners and amplifiers (not to mention micro components) utilize highly advanced light-weight pulse power supplies whose levels of distortion are virtually unmeasurable.

Or how they use a NASA developed "ThermoDynamic Cooling System" that eliminates heat, excess wire and the distortion and interference that normally accompany them.

If you'd like to hear more about the complete line of Sony hi-fi components (or if you need the name of your nearest dealer) write to Sony, P.O. Box CN 04050, Trenton, New Jersey 08650.

In the meantime, if somebody makes noise about innovations in high fidelity, think of the biggest pioneer in audio. And remember Sony.

SONY AUDIO

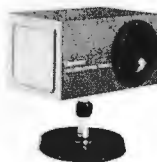
We've never put our name on anything that wasn't the best.

consisting of an ac-powered base station and a pocket-size, battery-powered remote unit. Incoming calls—the only ones the system handles—cause a beep in the remote unit. To answer, the user simply extends the antenna and presses the TALK button on the side of the unit. Alternatively, the Muraphone can be used as an intercom between the base telephone and the remote unit. Dimensions are $7\frac{3}{4}" \times 6\frac{3}{4}" \times 2\frac{1}{4}"$ (197 × 162 × 54 mm) for the base unit and $7\frac{1}{2}" \times 2\frac{3}{4}" \times 1\frac{1}{2}"$ (191 × 73 × 38 mm) for the remote. Maximum range is said to be 700 ft (213 m). \$90.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Film-to-Videotape Converter

Quasar's new Film-to-Tape Converter, Model KT502, is said to permit quick, simple transfer of any film format to videotape. The system accepts 8-mm, Super-8, 16-



mm, and 35-mm formats, and the transfer can be monitored through a TV set while in progress. Setting up the converter is said to be simple and require little time. \$130.

CIRCLE NO. 96 ON FREE INFORMATION CARD

MOSFET Power Amp Kit

Model DH-200, the first power amplifier kit announced by the David Hafler Company, uses the new Hitachi MOSFET output devices in a circuit that is said to be com-



pletely original. The manufacturer claims the minimal crossover distortion characteristic of Class A without disadvantages of that mode of operation. Rated output is 100 watts per channel into 8 ohms, 20-20,000 Hz with no more than 0.02% THD. Reactive loads are said to be handled without the creation of interface distortion. Pretested modules, comprising all of the active circuitry, simplify the task of assembly. \$300.

CIRCLE NO. 97 ON FREE INFORMATION CARD

THE FUJI CHALLENGE

Try the others. Then try ours.

When it comes to choosing the best tape, a minute of *listening* will tell you more than hours of specs. Because the best tape for *you* depends solely on the sound *you* like and the response of *your* deck.

At Fuji, we make the most advanced magnetic tape in the world—for video as well as audio. We'll match our specs against anyone else's, but we respectfully suggest you stop reading and start *listening*. Once you compare Fuji FX-I or II to any other premium tape, there's nothing more to say. We have confidence in your ears.

FUJI

Magnetic Tape Division
of Fuji Photo Film U.S.A., Inc.
350 Fifth Avenue,
New York, New York 10001



CIRCLE NO. 23 ON FREE INFORMATION CARD

Half-Speed Cassette Deck

The new Model 680 two-speed cassette deck with metal-tape capability from Nakamichi operates at $1\frac{1}{4}$ and 15/16 ips. Highly advanced magnetic heads are said to result in minimal loss of fidelity at the lower speed. Other features included in this three-head deck are Random-Access Music Memory, which by counting the pauses



between selections can automatically find any piece of music on a tape, fluorescent level indicators for recording and playback, and a diffused-resonance transport system claimed to reduce flutter effects. Specifications for low-speed operation with metal-particle tape include frequency response of 20-15,000 Hz, ± 3 dB and wow and flutter of less than 0.08% wrms. Corresponding specs at $1\frac{1}{4}$ ips are 20-20,000 Hz and less than 0.04% wrms. Signal-to-noise ratio is specified as better than 60 dB at low speed, better than 66 dB at high, both A-weighted, using metal tape and Dolby. \$1350.

CIRCLE NO. 98 ON FREE INFORMATION CARD


Introducing...

The Fresh-Air Phenomenon

Guaranteed to Control Odors.

Now, through this exclusive scientific breakthrough, indoor air can be purified in exactly the same way outdoor air is purified by lightning during a thunderstorm.



listed by 

U.S. Government Patent No. 3,925,673

Think of that sweet "country fresh air" smell following a thunderstorm. That's actually the absence of odor. The electrical activity in the air created by lightning adds a small negatively-charged electron to each oxygen molecule in the air. Science has long recognized the miracle of this phenomenon known as ionization. Amazingly, these ionized molecules combine with any odor-bearing molecules in the air—destroying them.

The Environ-air unit's patented process electrostatically creates these same negatively-charged oxygen molecules that permeate any enclosed space and attract odor molecules like a magnet until they're totally "neutralized."

BEFORE ENVIRON-AIRE

There were two ways to control odors: *Dilute*—constantly recycle fresh air to dilute odor molecules or *deodorize*—constantly mask odor with a heavy perfume scent. Now, with Environ-air, there's a third, more effective and highly scientific way. And that's to *destroy* all organic odor molecules electronically.

WHAT THE ENVIRON-AIRE IS NOT

It's not a one-shot cover-up. It doesn't mask odors—it destroys them electronically. And it kills tough odors *continuously*—not temporarily like sprays, wicks, stick-ons, etc. There are never any chemicals to buy, bulbs to burn out or filters to replace. The unit uses only as much electricity as a 25-watt light bulb.

WHAT IT IS

The Environ-air is a *continuous* air-cleansing process so unique it's patented. It uses the latest in space-age electronic technology to create the first energy and cost-efficient air purification system for the home. Even in a

smoke-filled room, you will be breathing only clean, fresh air all day long.

FORCED AIR—THE MOST IMPORTANT NEW FEATURE INNOVATION

One of the secrets of this new system is that it keeps the ionized air in *constant motion*. The Environ-air is the *only* electronic air freshener that *continuously* "pumps out" ionized oxygen molecules into the air, permeating every square inch of space—ready to attack and deactivate any odor-causing molecules instantaneously. Keeping the ionized air circulating is such an important factor that so-called "space age" air fresheners without it are truly outdated. Without it, odor-killing molecules simply fall to the ground near the unit, rendering them useless against odors.

A DUST-FREE ENVIRONMENT: AN UNEXPECTED BONUS

The Environ-air also de-activates dust particles suspended in the air. The ionized oxygen pumped into your room will attach itself to any impurities in the air, causing them to fall to the ground. Ahhhh...what's left is pure, clean air.

PROVEN EFFECTIVE IN HOSPITALS, FISH MARKETS, PET SHOPS & MORE

Prior to this special introduction to consumers, hundreds of Environ-air units were used by businesses with their own peculiar odor problems. After using it for over 8 months they found it to be the only answer to annoying, persistent odors. Why? Because it outperforms other systems in what it does and how it does it.

TO USE IT IS TO LOVE IT

You will feel the difference immediately. The Environ-air will cleanse any 20' x 20' room of odor-causing molecules within just 5 minutes!

Imagine how exhilarated you'll feel with a fresh supply of ionized oxygen surrounding you day and night!

CLEAR THE AIR ONCE AND FOR ALL

In the kitchen...bathroom...basement...nursery...pet areas...smoke-filled offices. Use it anywhere stale, musty, offensive or pungent odors are a problem. The attractive wood-grain unit is compact—10" x 6" x 4" deep—and lightweight—only 8 pounds. It can be wall mounted as an inconspicuous permanent fixture where annoying odors tend to accumulate. Or, it can be moved from place to place as needed, taking up little space on a shelf or floor. And installing it is simple—just plug it in. It uses regular household current.

LET YOUR NOSE PROVE ITS EFFECTIVENESS IN YOUR HOME OR OFFICE

The Environ-air may sound too good to be true. That's why we offer a 30-day trial period and ask you to really give it a workout. For starters, simply turn the unit on, then cut up a big, juicy onion. No tears. No smell.

SOLIDLY BACKED

If anything goes wrong with your unit during the first year Environmental Electronics Corporation will repair it—without charge. Although the Environ-air is built to last and be virtually maintenance free, it's still nice to know the manufacturer is service conscious.

SPECIAL INTRODUCTORY PRICE

The Environ-air is manufactured for Cambridge International by EEC. We are offering this exciting new product directly to our customers exclusively through the mail for only \$119.95 during our national introduction. Order one at no obligation today.

 **CAMBRIDGE INTERNATIONAL, Inc.**
8700 Waukegan Road, Morton Grove, Illinois 60053 (312) 966-5510

Order Now—Call Toll Free
800-621-5559

(In Illinois call 800-922-5858)
24 Hours A Day—7 Days A Week

5 UNBREAKABLE PROMISES WE MAKE TO YOU

We promise that each exciting product we introduce to you has been carefully evaluated and judged by an independent panel of consumers and found to be:

1. A genuine value at a special price
2. Made of only the finest quality components
3. Covered by the manufacturer's own warranty plus our added 30-day money-back guarantee
4. Excellent enough to earn government approvals or UL listings (when applicable)
5. Developed from the most advanced technology available

Clip and mail to:

Cambridge International, Inc. Dept. P#10
8700 Waukegan Rd., Morton Grove, Ill. 60053

☐ Please rush me _____ Environ-air unit(s) at just \$119.95 each plus \$6.95 shipping & handling. (Ill. residents add 5% tax.) I understand that if I am not absolutely satisfied with my purchase, I may return it within 30 days for a prompt and courteous refund.

☐ Check or MO enclosed. ☐ Charge to: ☐ Visa ☐ Master Charge
☐ American Express

Account # _____ Exp. Date _____

Name _____

Address _____

City _____ State _____ Zip _____

Signature _____

**NRI training in TV
and Audio Servicing
keeps up with the
state of the art.
Now you can learn to
service video cassette
and disc systems.**



RUSH THIS POSTAGE-PAID CARD FOR YOUR FREE CATALOG.

NO SALESMAN WILL CALL.

NEW FROM NRI...

- TV/Audio/Video servicing courses with computerized TV that programs an entire evening's entertainment
- All-new Computer Electronics courses with designed-for-learning microcomputer you build and keep
- New Professional Appliance Servicing courses with training in solid-state and electronic controls
- Complete Communications course with digitally synthesized transceiver you assemble as you learn



POPULAR ELECTRONICS

Name _____ (Please Print) _____ Age _____

Street _____

City _____ State _____ Zip _____

Accredited by the Accrediting Commission of
the National Home Study Council

1-109

CHECK ONE:

- ☐ Color TV, Audio, and Video System Servicing
- ☐ Computer Electronics Including Microcomputers
- ☐ Communications with CB • Complete Communications Electronics • FCC Licenses • Aircraft Electronics • Mobile Communications • Marine Electronics
- ☐ CB Specialist Course
- ☐ Amateur Radio • Basic and Advanced Courses
- ☐ Industrial & Business Electronics • Digital Electronics • Electronic Technology • Basic Electronics
- ☐ Small Engine Servicing
- ☐ Electrical Appliance Servicing
- ☐ Automotive Mechanics
- ☐ Auto Air Conditioning Specialist
- ☐ Air Conditioning, Refrigeration, Heating and Solar Technology Courses

All career courses approved
under GI Bill. Check for facts.



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 10008 WASHINGTON, D.C.

POSTAGE WILL BE PAID BY ADDRESSEE

NRI Schools

McGraw Hill Continuing
Education Center
3939 Wisconsin Avenue
Washington, D.C. 20016





You build color TV, hi-fi, professional instruments.

Now, in addition to learning color TV and audio systems servicing, you get state-of-the-art lessons in maintaining and repairing video cassette recorders, and the amazing new video disc players, both mechanical and laser-beam types.

Learn at Home in Your Spare Time

And you learn right at home, at your own convenience, without quitting your job or going to night school. NRI "bite-size" lessons make learning easier... NRI "hands-on" training gives you practical bench experience as you progress. You not only get theory, you actually build and test electronic circuits, a complete audio system, even a color TV.

Build Color TV with Computer Programming

As part of your training in NRI's Master Course in TV/Audio/Video Systems Servicing, you actually assemble and keep NRI's exclusive designed-for-learning 25"

(diagonal) color TV. It's the only one that comes complete with built-in computer tuning that lets you program an entire evening's entertainment. As you build it, you introduce and correct electronic faults, study circuit operation, get practical bench experience that gives you extra confidence.

You also construct a solid-state stereo tuner and amplifier complete with speakers. You even assemble professional-grade test instruments so you know what makes them tick, too. Then you use them in your course, keep them for actual TV and audio servicing work.

NRI Includes the Instruments You Need

You start by building a transistorized volt-ohm meter which you use for basic training in electronic theory. Then you assemble a digital CMOS frequency counter for use with lessons in analog and digital circuitry, FM principles. You also get an integrated circuit TV pattern generator, and an advanced design solid-state 5" triggered-sweep oscilloscope. Use them for learning, then use them for earning.

NRI Training Works... Choice of the Pros

More than 60 years and a million students later, NRI is still first choice in home study schools. A national survey of successful TV repairmen shows that more than half have had home study training, and among them, it's NRI 3 to 1 over any other school.

(Summary of survey on request.)

That's because you can't beat the training and you can't beat the value! For hundreds of dollars less than competing schools, NRI gives you *both* color TV and audio...



Other NRI training includes Computer Technology, Complete Communications Electronics.

and now includes training in video cassette and disc systems. Send for our free catalog and see for yourself why NRI works for you.

Free Catalog... No Salesman Will Call

Send today for our free 100-page catalog which shows all the kits and equipment, complete lesson plans, and convenient time payment plans for courses to fit your needs and budget. Or explore the opportunities in other NRI home study courses like Microcomputers & Microprocessors, CB and Mobile Radio, Aircraft and Marine Radio or Complete Communications. Send the postage-paid card today and get a head start on the state of the art. If card has been removed, write to:



NRI Schools
McGraw-Hill Continuing
Education Center
3939 Wisconsin Ave.
Washington, D.C. 20016



Learn at home at your convenience.



Stereo Scene

By Harold A. Rodgers
Senior Editor

ADVENTURES WITH AMBIENCE

SINCE THE demise of four-channel, time delay has become the darling of those who seek to recreate concert-hall ambience in the listening space. But listening to time delay in operation at times is sufficient to give one pause. Too often the music sounds as if some atavistic force were propelling us back to the caves—and echoey ones at that. Simply, many users of time delay, encouraged by misleading controls and heavy-handed hype, are applying too much of a good thing. Accordingly, let's examine the nature of reverberation as it applies to musical performance and perception and explore how we can simulate it in a listening room so it actually enhances the music.

It is well known that a reverberant sound field carries information about the space in which a sound is produced. The size of a room is reflected in the quality of its echos, as is the absorptivity of its interior surfaces. Reverb also tends to broaden the apparent dimensions of sound radiators and make their locations less precise. Beyond that, it adds a "tail" to every sound subject to it. Thus, in a reverberant space, a new sound usually occurs simultaneously with the tail of the preceding sound.

For musical purposes, this last property can be rather critical, for it determines, at least to some extent, how rapidly a composition can be performed and remain intelligible. Consider a hall having a reverberation time of two seconds (a fairly common value) and assume that the decay of reverberation in the hall is linear with time. That means that the reverb is down 60 dB in two seconds, 30 dB in one second, etc. Now if the music suddenly drops in level by 35 dB, say, from forte to piano, the note following the shift must last longer than a second if its level is ever to exceed the reverberation from the note before. Thus, if the conductor chooses too fast a tempo, the first note to be played softly in a case like this might not be heard clearly—or even at all! Note, however, that in a hall with a reverb time of one second (a little on the "dry" side) a faster tempo could work perfectly well.

Conductors, of course, know about this and choose tempos partly on the basis of hall acoustics. But choosing a sufficiently slow tempo is not the end of the story. Apparently, the "collision" of a note and the tail of the preceding note is a factor that adds interest and excitement to music. Consequently, if the reverb is allowed to die out before a significant clash occurs, the music will likely appear

to lack vitality. This means that a tempo can as easily be too slow for the prevailing acoustics as too fast. (A case can be made that the very fast tempos used by Toscanini in his recordings of the Beethoven Symphonies with the NBC Symphony were not the result of a stunning new insight into Beethoven, but rather an accommodation to the notoriously dry acoustics of the studio in which the recordings were made.)

Now let's consider the influence of hall size. Ultimately, the linear dimensions of a hall determine how far a sound can travel before being reflected and, therefore, the longest time that can elapse between a sound and a delayed near-replica of itself. Generally speaking, it is best to limit this time to 40 ms or so, approximately the fusion time of the ear; otherwise the reflections may be heard as separate and distinct entities rather than blending into continuous reverberation.

One might suppose that the longest dimension of a concert hall, usually the distance from front to back, would determine the longest delay. This is rarely the case, though. Usually, reflections from the rear wall cause so many problems that acousticians go to considerable pains to suppress them. Or, failing that, they design the hall so that the direct sound is very weak at locations where the rear reflection is strong. As a consequence, occupants of some seats hear almost no direct sound at all.

At first glance, it may seem that adding diffuseness to the locations of sound sources (which reverberation indeed does) will conflict with adequate stereo imaging, but this is not necessarily so. Actually, the radar-like precision that some listeners seem to enjoy in a stereo image is an artifact of close-miked recording. (Try closing your eyes at a live concert and see how close you can come to locating an instrument by its sound.)

What properly recovered or synthesized reverb will do is make the locations just vague enough that instability due to minor errors or gain and/or frequency response between the signal channels will be far less noticeable. The stereo image, therefore, should be improved, not worsened.

We have now established some criteria, albeit vague ones, by which to decide what we want an ambience-simulation system to do (and not do).

It should: (1) Produce a smooth reverberation without perceptible single echoes. (2) Soften the sense of location just a bit.

It should not: (1) Obscure any musical detail. (2) Introduce any distortion or coloration of its own.

How Time Delay Works. Most time-delay "boxes" try to create an electronic analog of a performance environment. This is done by using delay lines to simulate sound traveling through the air and by recirculating the signal through the lines to simulate multiple reflections. Such niceties as multiple taps on the delay lines and/or crossfeed between the two stereo channels are often applied to enhance quality of the electronic analog, but cost generally precludes exactitude in the duplication. We must settle for fewer delays and recirculative paths than would be ideal.

Despite these compromises, devices of this kind have proved themselves capable of fine performance when applied with moderate delay and recirculation to program material that is fairly "dry", that is, without much reverb of its own. This creates the illusion of a musical performance in the "environment" synthesized by the box.

When the program material is not dry, the situation is different and, on theoretical grounds, potentially troublesome. Ignoring listening-room effects, as we have to this point, the ambience box in effect replays the already reverberant recorded signal in a synthetic room before routing it to our speakers. This creates a reverberation pattern that could not occur in the real world. However, the effect can be highly listenable if the record reverb and that added by the box are sufficiently random.

What can sometimes happen though, is that once the level in the rear speakers is high enough to move the reverb's directionality away from the front speakers, conflict between recorded and synthetic ambience becomes apparent. In some cases, this level of reverberation will obscure musical details. Another problem with this approach is that each piece of music is likely to require its own control setting, which will have to be found by trial and error.

Enter the Madsen Effect. Some years ago, Ernst Madsen of Bang & Olufsen, experimenting with the Haas effect—the phenomenon by which the ear becomes "deaf" to the repetition of a sound that occurred a few milliseconds earlier—discovered that it could be used to recover ambience from recordings. How Madsen arrived at his findings is beyond the scope of this column, but his setup consisted of a normal stereo pair of speakers at the front and a second pair off to the sides. When signals to the second pair were delayed so as to reach the listener 5-15 milliseconds after the sound from the front pair, the listener felt that he was surrounded by the ambience of the hall in which the recording was made. By trying this arrangement with a recording made in an anechoic room, Madsen showed that the sense of ambience was not an artifact of the time delay. This recording sounded just as "dead" with the time delay as without; the only change was a modest increase in loudness due to the power contributed by the back speakers. It is more than a little surprising and ironic that this technique, that exploits a peculiarity of human hearing rather than attempting to model reality, is the one that gives the more convincing results.

NOBODY CAN MATCH OUR PERFORMANCE BECAUSE NOBODY CAN MATCH OUR TECHNOLOGY.

Kenwood has consistently made the significant technical advancements that make a difference you can hear. Like the first introduction of DC into integrated amplifiers.

And now, Kenwood does it again. Our exclusive *Hi-Speed amplifier* has actually changed the standards by which high fidelity is measured. It reacts much faster to changes in the music, particularly in the mid to upper frequencies. So all the subtleties of the music come through—even an individual singer in a backup vocal group.

In our tuners, we've developed *Pulse-Count Detector circuitry* to digitally reduce FM distortion by half while significantly reducing background noise. You'll hear the difference in your FM reception as a more distinct, clearer sound. And only Kenwood has it.

In fact, every Kenwood component has exclusive features that improve sound quality. Like turntables with resin-concrete bases that virtually eliminate unwanted vibrations, and an extra-heavy, high inertia platter that keeps the record speed constant. And our dual-belt cassette decks that use a unique, extra-heavy flywheel for constant tape speed and better reliability.

Your Kenwood dealer can demonstrate how these features actually improve the tonal quality of your music.

And that's what great performance is all about.



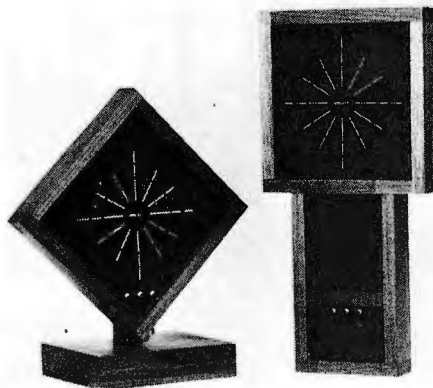
For the Kenwood dealer nearest you, see your Yellow Pages,
or write Kenwood, P.O. Box 6213, Carson, CA 90749.
In Canada: Magnasonic Canada, Ltd.
CIRCLE NO. 32 ON FREE INFORMATION CARD

Grandfather's Clock Was Never Like This!

STEREO SCENE

continued

Setting It Up. The first step is to make sure that your secondary speakers are off to the sides and no more than slightly toward the rear. Then, if your ambience generator has a straight-delay mode, engage that and route the delayed signals to the secondary speakers. Otherwise, set recirculation to zero. Next, estimate or measure the distance from either of your front speakers to the listening position (it should be the same for both). Do the same for one of the side speakers and subtract the distance from the front speakers, retaining the minus sign if the difference is negative. Subtract that number from 15 and set the delay for the difference in milliseconds (we have been using the approximation that sound travels one foot per millisecond), and you've completed the basic setup.



If you love contemporary design but want the more traditional, here is the clock for you. In creating our own version of the ever popular Grandfather Clock, we use the electronic eye to display each second, minute, and hour, and also the simulated pendulum motion.

The diagonal model which has no simulated pendulum is available for wall mounting or with base as a desk clock.

Our synthesized sounds composed of tic toc, modified Westminster Chimes and Bongs are available for any AMELECT clock. The chimes and bongs are composed of six frequencies, providing realistic bell sounds. They are totally within clock cabinet.

The AMELECT clocks, cabinets may be your choice of Cherry, Mahogany, Maple, or Walnut hardwoods.

Assembled Kit Base

CL7401A Diagonal	\$75.00	\$55.00	\$8.00
CL7402 Grandpa	\$95.00	\$71.50	
Chimes	\$45.00	\$39.00	

Shipping and Handling, \$3.50

To order write or call

Allow 4 to 6 weeks for delivery

AMELECT

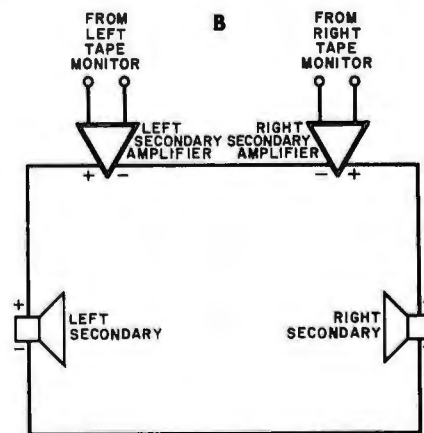
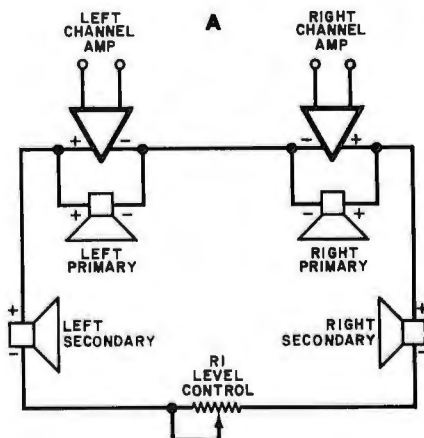
INCORPORATED

Postoffice Box 367

GOODLAND, INDIANA 47948

Phone 219-297-3320

CIRCLE NO. 3 ON FREE INFORMATION CARD

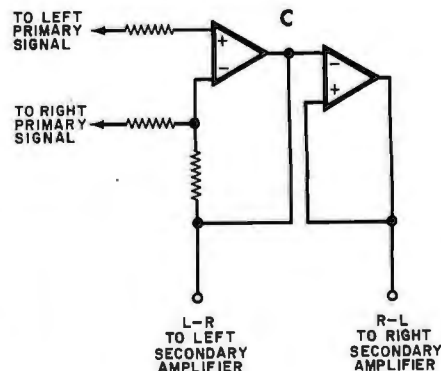


All you have to do now is balance ambience with the direct sound and adjust treble balance for the side speakers so that switching them in adds minimum coloration. Although these adjustments vary from one recording to the next, the delay setting does not.

From time to time you will run into recordings so inherently dry that you cannot recover ambience from them. Here is where you will use the other controls on the box. You may find that adding more delay and recirculation will help. Another possibility is that you have a recording in which you feel the tempo is too slow. It may be possible to make it seem faster—or at least make its slowness seem more

acceptable—by adding delay and recirculation. In this way, time delay adds greatly to the power in the hands of the closet conductor or record producer.

Low-Cost Experiments. If you look back to the way in which we calculated the length of artificial delay, you will see that there is a possibility (if the geometry of your room permits) of placing the side speakers far enough away from the listening position that the Madsen effect takes place with no artificial delay. The secondary speakers in many cases can be driven by the same amp as the primaries. However, slightly better results are obtained if the secondary speakers have their own amp, so that lowering levels will not interfere with damping. Even in quite a small room fairly long delays can be achieved by aiming the secondary speakers so that their sound bounces from a wall before reaching the listening position. (For this application,



The Hafler Effect. In A, the secondary speakers are connected in series across the "hot" terminals of the main amp. Potentiometer R1, with a rating of 50 to 100 ohms and 10 to 20 watts, controls secondary level. Secondary speakers must be at least as efficient as primaries, and R1 may interfere with woofer damping. In B, the secondary pair is driven by a secondary amplifier whose gain is varied to set levels. Damping is better, but series connection of speakers may still interfere. In C, subtraction is done at low level and signal is routed to secondary amp with speakers connected conventionally. Rear channels of a matrix decoder may substitute for set-up in C.

beaminess is a virtue in a loudspeaker.)

And there are the more traditional ways to extract ambience, such as using the "ambience" position of a matrix decoder or using the Hafler effect to extract a difference signal. These are shown in the accompanying diagrams and nothing more will be said about them except the following: if front-channel crosstalk is a problem with any of these hook-ups, increasing the distance to the secondary speakers and rolling off some of their high frequencies will sometimes give relief. These methods, like the Haas effect, depend on ambience included in the recording. If there's not enough, the adjustable delay and recirculation of a time-delay box will be needed. ◇

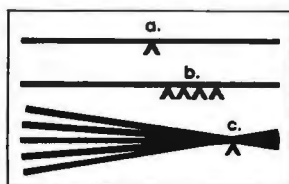
We found the optimum pivot point before the others even knew it was missing.

Most manufacturers are content to determine tonearm pivot points by trial-and-error. And many tonearms are so susceptible to external vibrations that you have to tiptoe around the turntable.

With Sansui's Dyna-Optimum Balanced (DOB) tonearms, based on our Optimum Pivot Point principle, the transmission of vibrations is dramatically reduced to give you more freedom to enjoy your music. It's used in our new, fully automatic direct-drive FR-D4 and FR-Q5.

Here's how the DOB works: Put a pencil on a table. Wiggle one end back-and-forth. The other end will move; but a certain point will not. This is the Optimum Pivot Point.

In our new DOB tonearm the arm is pivoted at this highly stable point. With no relative motion between the point and the arm support, effects from external forces are minimized. Friction is almost non-existent, so the stylus is



a. Center of Mass. Starting point for conventional tonearm designs.

b. Typical trial-and-error pivot points, usually placed close to **a.** so that counterweight is not too heavy, tonearm not too long.

c. Sansui's Optimum Pivot Point. Calculated mathematically as a function of length and mass. The most stable point.

free to trace every part of the groove. We also added a special decoupling device and a unique counterweight for optimum tracking.

A patent is pending on Sansui's brushless DC motor used in the FR-D4 and FR-Q5. And with the Quartz-PLL system of the FR-Q5 and the special speed-error detection/correction system of the FR-D4, wow and flutter, speed accuracy and signal-to-noise specifications are outstanding. All operations are computer-controlled using the latest LSIC technology. The computer even knows to shut off the motor if you forget to unlock the tonearm clip.

To make the FR-D4, FR-Q5, as well as the budget-priced direct-drive FR-D3 even more convenient, we put all the controls up-front, outside the dustcover.

Ask an authorized Sansui dealer to demonstrate our new turntables. Listen closely and you'll hear what the others are missing.

SANSUI ELECTRONICS CORP.

Lyndhurst, New Jersey 07071 • Gardena, Ca. 90247
Sansui Electric Co., Ltd., Tokyo, Japan
Sansui Audio Europe S.A., Antwerp, Belgium
In Canada, Electronic Distributors

CIRCLE NO. 50 ON FREE INFORMATION CARD

Sansui



Julian Hirsch Audio Reports



H.H. Scott Model PRO 100B bidirectional three-way speaker system



The Model PRO 100B, which heads Scott's line of speaker systems, is an improved version of the Model PRO

100. This floor-standing three-way system is designed to supply a mixture of direct and reflected sound to the listening area, in adjustable proportions. It also shares with other Scott speaker systems a "controlled-impedance" characteristic that maintains impedance at or above the rated value throughout the entire audio frequency range. Although it is relatively efficient, the PRO 100B has a nominal 150-watt power rating. Its tweeters are protected against overload by a novel passive circuit.

The system's walnut-veneer cabinet measures 29 1/4"H x 19"W x 14 1/2"D (743 x 483 x 368 mm). Overall weight is 67 lb (30.5 kg). Black grille cloths, held in place by snap fasteners, cover the front and top of the cabinet. Level-control switches are located below the top grille, and input terminals are recessed into the back of the cabinet. Suggested retail price is \$549.95.

General Description. The heavy-duty 15" (381-mm) woofer has a 2" (51-mm) diameter voice coil and operates in a 3.3-cu ft sealed enclosure. The cone's edge is damped to provide a high-frequency response rolloff to supplement the effect of the crossover network. At 750 Hz, there is a crossover to a pair of 4 1/2" (114-mm) diameter midrange cone drivers housed in individual tuned isolation chambers within the main enclosure. One of these drivers faces forward, while the other radiates up-

ward. At 3500 Hz, there is a second crossover to a pair of 1" (25.4-mm) soft-dome tweeters arranged like the midrange drivers, with one facing forward, the other up.

On the top of the cabinet, there are three three-position toggle switches. Two control the levels from the midrange and high-frequency drivers, providing 0- ("flat"), and -3-, and -6-dB output-level selection. The third switch alters the ratio of upward-to-forward radiation and affects both the midrange and high-frequency speakers. At maximum, the top speakers radiate 50% of the total power in their respective frequency ranges. The other switch settings reduce upward radiation to 35% and 25% of the total while keeping the latter constant. Unlike some other speaker systems that combine direct and reflected sound (including Scott's PRO 100), the PRO 100B has a minimum dependence on the characteristics of the wall behind it. It can even be used in some normally unacceptable locations, such as on both sides of a sofa, without suffering serious reduction in listening quality.

its low bass
distortion
readings correspond
to very loud
listening levels

The tweeters are protected by a small filament lamp in the crossover circuit. The lamp serves as a current-sensitive resistor that, under normal operating conditions, has a resistance of less than 1 ohm. When power to the tweeters approaches unsafe levels, the filament heats up and resistance increases, limiting current and protecting the tweeters against burnout.

Laboratory Measurements. Frequency-response measurements in the reverberant field of our test room were made initially with all level switches "flat" (0 dB) and with equal radiation from the forward- and upward-facing drivers. When we used the other ratios of front-to-top radiation, the high-frequency response was exactly the same, confirming that our measurement closely approximated a total power output response. Horizontal dispersion was excellent; exactly the same response was measured on-axis and 30° off-axis.

The midrange level switch affected the output between 750 and 3500 Hz but had a range of only about 3 dB instead of the indicated 6 dB at its maximum point (2500 to 3000 Hz). The high-frequency switch had a total range of about 7 dB and took effect above 3000 Hz.

A close-miked woofer response revealed a moderate rise of about 2.5 dB in the vicinity of 60 Hz and rolled off at a 12-dB/octave rate below about 50 Hz. When this curve was spliced to the middle- and high-frequency curve, the result was an extraordinarily "flat" response free of most of the irregularities normally found in "live-room" measurements, even when considerable smoothing is used. The overall response of ± 2.5 dB from 35 to 20,000 Hz is impressive in its own right and surpasses Scott's rated response of ± 4 dB from 36 to 20,000 Hz.

System impedance is nominally rated at 4 ohms and, as claimed, it never fell below that. The minimum occurs between 8000 and 10,000 Hz. Over most of the audio band, the impedance measured 5 to 8 ohms. Maximum impedance, about 14 ohms, occurred at 45 Hz.

Bass distortion of the system was measured at nominal inputs of 1 and 10 watts. At 1 watt, distortion was barely measurable from 100 Hz down to 70 Hz, with readings on the order of 0.1% to 0.2%, rising to 0.5% at 50 Hz and 2% at 35 Hz. At a 10-watt level, the distortion had a similar distribution, with readings of 0.4% to 1% down to 60 Hz and 5% at 35 Hz.

Sensitivity of the PRO 100B is rated 94 dB at 1 meter on-axis when driven by 1 watt of pink noise. In our tests, 2.83 volts of noise in the octave centered at 1000 Hz produced a 93-dB SPL at 1 meter. This does not include the full contribution of the top drivers, since the microphone was located in front of the cabinet and below its top edge. The high sensitivity of this system makes its low bass distortion readings especially noteworthy, since they correspond to very loud listening levels.

Tone-burst response was good, with no signs of serious discontinuities or ringing.

(continued on page 28)



OUR \$69 SOLAR ALARM. A CHALLENGE TO EVERY CHRONOGRAPH IN THE WORLD.

People are bumping into more watch ads these days than at any other point in history.

And if you think companies like Seiko with their \$295 solar alarm chronographs are fighting hard for a place on your wrist, you should see the battle in the Under-\$100-Watch Category.

It's Dog-Eat-Dog.

So where did we get the gumption to offer *another* popular-priced mini-genius through the mail? You'd have it too, if you had this watch.

Our \$69 Xernus (its price in stainless) provides every watch and stop-watch function you could ask for (see description below).

Even more important, it offers a level of workmanship and design that you just won't find elsewhere—at even \$20 or \$30 more.

We know, we've looked.

Its display is liquid crystal; the digits are crisp and clear. You get the uncommon convenience of a 24-hour alarm, precise time information for two different time zones. Plus, the latest solar cell technology—to keep your Xernus working for up to 5 years on its original set of batteries. And with an uncanny ± 15 seconds per month quartz accuracy. By the way, Xernus is pronounced *Zernus*.

Its case, bracelet and back are machined from solid stainless steel. Instead of the thinly plated chrome construction you find on virtually all other

chronographs at or near its price.

It's also an incredible 8mm thin. Much thinner than the Texas Instruments alarm chronograph; much, much thinner than the widely advertised Jupiter. Xernus is even trimmer than the comparably clever \$295 Seiko. By more than 2 mm.

Want more? You get a face crystal that's made from tough, hard mineral glass. Most other chronographs in this price field give you nothing better than plastic. And nothing picks up scratches faster than plastic.

Save \$60 while Xernus is hungry.

This isn't a small watch company, or even a very new one. In fact, this pioneer in microcomputer timepieces has

already sold a phenomenal number of chronographs around the world; in countries like Germany, Switzerland and France.

This superb timepiece has been practically everywhere but the U.S. And for that reason, Xernus has agreed to let us offer their chronograph at a dramatic discount. In stainless, it lists for \$129, but you get it at a \$60 savings.

You save even more when you order the Xernus solar alarm in gold (a generous 5 microns over stainless). To be exact, \$70 less than your friends overseas have to pay.

Each Xernus comes gift-boxed with full instructions, service-by-mail convenience, if needed, and a full one-year guarantee against defects by its manufacturer.

And The Sharper Image gives you two weeks to decide if it's really the watch for you. If not, simply send it back as new for a full and prompt refund. But order now to take advantage of this special introductory price.

ORDER TOLL-FREE.

Credit card holders may use our toll-free ordering number. Or send check for \$69 for stainless, \$79 for gold (In California, add \$4.14 and \$4.74 sales tax respectively). Plus \$2.50 delivery.

800 227-3436

In California 800 622-0733

THE SHARPER IMAGE™

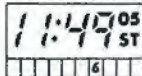
260 California St., Dept. XE-049
San Francisco, CA 94111
(415) 788-4747

Normal time display:



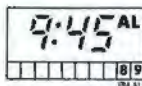
See hours/minutes/seconds, AM/PM, day, date on command.

Stopwatch display:



12-hour timing to 1/10 second. Even lap and 1-2 finishes.

Alarm setting display:



Set for AM or PM. Audible beep lasts a full minute.

Calendar setting display:



Set time/date for 2 time zones. End-of-month adjustment is automatic.

Extra light at night.



Push a button for bright face illumination.

PRODUCT GALLERY

Here is a selection of useful products that are suited for your own use or for gift-giving.

A. ACRYLIC CADDY on casters has compartments for 8-tracks, cassettes and records! #24191 \$55.00 (4.10)

B. CURRENT CONVERTERS. An excellent set that will take you traveling with confidence. Set includes a 50 watt converter, a 1600 watt converter and 4 adapter plugs. All packed in a convenient travel case. #24487 \$32.95 (1.95)†

C. SONY SWIVELVISION. Inside watch tv on AC current, outside on batteries. And the screen actually swivels side-ways, so you can lay your head on a pillow and turn the screen to match. Brilliant 5" black and white picture. Features include 100% solid state circuitry, quick start picture, glare-free screen, earphone, built-in battery recharger. Measures 6 1/4" x 11" x 11 1/8". #19144 \$189.95 (4.85)†

Adapter for car/boat use. #19145 \$12.00 (1.45)

D. GOLFER'S RANGE FINDER. A useful item... just sight the flag-stick in the viewfinder, read the distance and select your club. Ideal for any golfer who wants to know the distance to the green. Measures from 50 yds to 200+ yds. Only 2 1/4" x 2 1/4" x 1/2". #19748 \$9.95 (.90)

E. STATIONERY EMOSSER adds a classic touch to your personal stationery. Embosses top or bottom of paper and envelope flaps. No moving parts, nothing to break or wear out. Three line imprint. #14809 \$16.95 (1.85)*

F. AUTOMATIC TELEPHONE CALLING COMPUTER... the Micro-Dialer. It's a computer that remembers and dials any of 32 different telephone numbers at a touch, automatically redials, speeds emergency calls, and it's a desk-top calculator. Compute sales, purchases or budgets even while talking on the telephone. Perfect for home and business... highly efficient and more than a luxury. Works with any rotary or push-button telephone. #24114 \$199.95 (3.40)†



Order by phone!

Call Toll Free:
800-558-8990

In Wisconsin call:
(414) 352-9020

*Allow additional
delivery time.

† Warranty available.

() Price in parenthesis
indicates shipping charge.
Please add to unit cost of item.

Popular Electronics

P.O. Box 2774
Boulder, Colorado 80321

**No sales talk—just a special deal on
Popular Electronics: only \$8.97 for one year!
You save 40% off the annual newsstand rate.
On longer orders, you can save even more!**

Mr. _____
Ms. _____
(please print full name) 5S175

Address _____ Apt. _____

City _____

State _____ Zip _____

DISCOUNT ORDER FORM

CHECK APPROPRIATE BOXES:

- ☐ **YES!** Send me one year (12 issues) of **Popular Electronics** for just \$8.97—I save \$6.03.
- ☐ 2 years \$16.97—I save \$13.03.
- ☐ 3 years \$22.97—I save \$22.03.

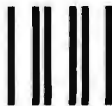
Savings based on annual newsstand rate of \$15.00.

CHECK ONE: ☐ Payment enclosed.
☐ Bill me later.

59048 ☐ Send me one year of
Stereo Review for \$4.99.

Foreign postage: Add \$3 a year for Canada. Add \$5 a year (cash payment in U.S. currency only) for other countries outside U.S. and possessions. Please allow 30 to 60 days for delivery of first issue.

NEW SUBSCRIBERS ONLY



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 906 BOULDER COLORADO

POSTAGE WILL BE PAID BY ADDRESSEE

Popular Electronics

P.O. Box 2774
Boulder, Colorado 80321





G



H

G. ACRYLIC RECORD CADDY on casters. Holds up to 50 albums. #17819 \$49.95 (3.50)

H. THE ELECTRONIC BLOCK... an electronic project set that takes you from fundamental knowledge of electronics to its practical applications. 100 various projects can be made easily by anyone, without a soldering iron. By connecting the modules in certain ways, you can create doorbells, a transistor radio, wireless microphone, garage door opener, circuit breaker, etc. All instructions included...it's a simple matter of rearranging the blocks. Built in power antenna, polyester variable condenser, slide switch, IC amplifier. #19761 \$59.95 (2.80)†



VAC-O-REC



J

I. VAC-O-REC eliminates micro-dust particles, static electricity and vacuum cleans records electronically. Uses the finest natural mohair brushes, operates on AC. Every album owner needs one. #14944 \$34.95 (2.60)†

J. THE TELEPHONE SILENCER. It will silence your phone rings so you don't hear them, yet the person calling will. Just think, while you're napping, reading, bathing, relaxing, you won't be disturbed by shrill phone rings. No need to take your phone off the hook either. Installs in minutes with a simple screwdriver. #66548 \$9.95 (1.10)



K

K. THE GREATEST, EASIEST TIMER we've found! A 24 hour, push button cycle lets you program appliance or lamp to turn on, off, on again, off again, etc. for an entire 24 hour period, for any number of days. Push in the pin at the time you want the appliance or lamp "on" for one hour. Pull out additional pins for the hours that you want the appliance off. Each timer accommodates one appliance, so you may want to order a few. 2 3/4" x 3 1/2" x 3". #17682 \$12.95 (1.85)†

L. NO MISTAKING YOUR WEIGHT! This computerized scale is all electronic...and shows an accurate weight in the form of a large red LED readout. Just step on and weight shows, step off and it automatically turns off. All solid state, operates for about one year on 4 penlite batteries. Digital readout in pounds or kilos. #66242 \$59.95 (3.15)†



PRODUCT GALLERY

Order by phone!
Call Toll Free 800-558-8990

SEND ORDERS TO:
Giftmaster Dept. GE-10
P.O. Box 1692
3825 W. Green Tree Rd.
Milwaukee, WI 53209

Allow 3-4 weeks
for delivery.

Print Name _____
Address _____ Apt. # _____
City _____
State _____ Zip _____

ITEM NO.	QTY.	DESCRIPTION	UNIT COST	TOTAL

CHECK METHOD OF PAYMENT

☐ Diners Club ☐ Master Charge
☐ American Express ☐ Visa
☐ Check or Money Order

Sub Total \$ _____

Add appropriate \$ _____
state sales tax.

Make check payable to Giftmaster, Inc.

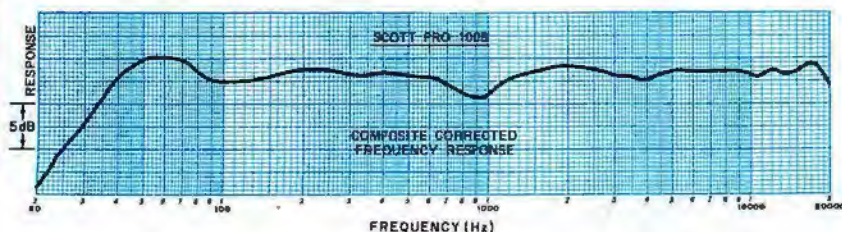
TOTAL \$ _____

Credit card orders without your signature and expiration date cannot be processed.

Credit Card No. _____ Exp. Date _____

Telephone No. () _____

Signature _____



Composite corrected frequency response for speaker system

User Comment. With all controls flat and using maximum upward radiation, the sound was a trifle "bright" by comparison to some other excellent speaker systems. When we reduced both middle- and high-frequency outputs by 3 dB, the sound

balance was very close to that of the comparison speaker systems. This shows that the sound of the PRO 100B speaker system can be adjusted with relative ease to suit almost any type of listening taste or acoustic environment.

Bass response, which always depends to some extent on room conditions and speaker placement, is deep enough for critical music listening, but did not have the floor-shaking character that we have encountered with some systems. However, the flexibility of adjustment afforded to the midrange and treble drivers should allow the balance to be tweaked to almost any reasonable bass characteristic one might possibly want.

This, in our opinion, is a speaker with a very fine sound quality. Its outstanding horizontal dispersion allows great freedom of choice with respect to listening position, and its high sensitivity and well-behaved impedance should give the driving amplifier a relatively easy time. Without a doubt, the performance of the Scott PRO-100B justifies its price.

CIRCLE NO. 101 ON FREE INFORMATION CARD



Pioneer Model TX-7800 AM/FM stereo tuner with servo-lock afc



Pioneer's Model TX-7800 AM/FM stereo tuner makes full use of the latest integrated circuit developments. It

features an FM "servo-lock" amplified afc system, controlled by a touch sensor through the tuning knob, a PLL multiplex decoder, and an audio amplifier IC with built-in muting. Even the AM tuner section has selectable wide and narrow i-f bandwidths to optimize noise and audio bandwidth for different receiving conditions.

The styling of the TX-7800 is distinctive and includes a satin-finish panel and walnut-grain wood cabinet. It measures 17 1/4" W x 15 3/4" D x 6 1/4" H (453 x 390 x

155 mm) and weighs 18 lb 5 oz (8.3 kg). Suggested retail price is \$350.

General Description. The AM and FM dial scales extend across most of the width of the front panel. Meters that indicate relative signal strength for FM and AM and

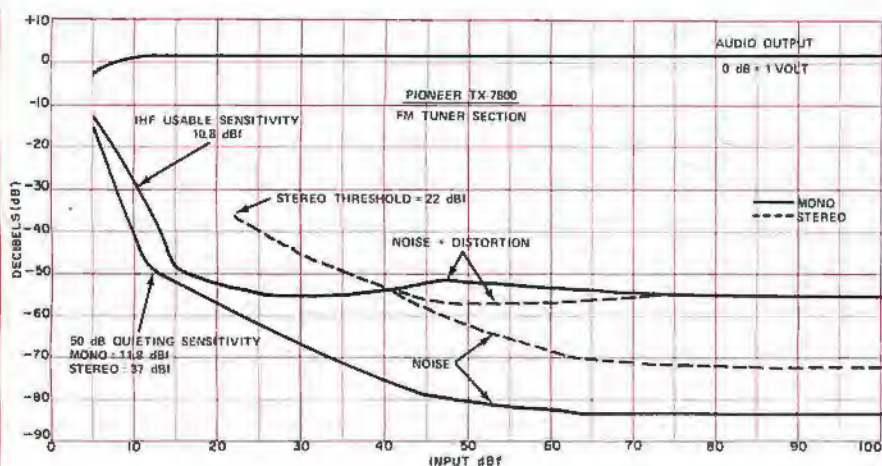
S/N for mono
was the highest
we have measured
on an FM tuner

center-channel tuning for FM are provided, as are red STEREO and green LOCKED indicators. The latter operates with the automatic "servo-lock" tuning system, which is actually a highly amplified afc circuit. Touching the large tuning knob defeats the afc voltage applied to a voltage-variable capacitor in the local oscillator. Once a station is tuned, even approximately, releasing the knob restores full afc action, locking the tuner solidly on the received signal and turning on the LOCKED indicator.

An OUTPUT LEVEL control varies signal level at the VARIABLE OUTPUT jacks on the rear apron. A second pair of jacks carries audio at a FIXED level. Lever switches control POWER, FUNCTION (FM or AM), AM IF BAND (WIDE or NARROW) and MPX NOISE FILTER that reduces noise on weak stereo signals by partially blending the channels at high frequencies. The FM MUTING/MODE switch simultaneously controls the tuner's mono/stereo operation and its muting system. In AUTO, the presence or absence of a 19-kHz pilot carrier determines the tuner's operating mode and muting is operative. Switching the tuner to mono reception disables the muting.

In addition to the two sets of audio jacks on the rear, there is a pair of MULTIPATH jacks for connection to the horizontal and vertical inputs of an oscilloscope to display multipath distortion. The horizontal output jack is also labeled DET OUT and carries a signal that can be used to drive any future four-channel FM decoding device. The antenna connections accept a 300-ohm or 75-ohm FM antenna, and a long-wire AM antenna, supplemented by a pivoted AM ferrite rod. A slide switch permits changing the FM deemphasis time constant from 75 to 25 microseconds for use with an external Dolby decoder. Another switch provides two degrees of sensitivity for the touch sensor that operates the tuning-lock system. There is also a single unswitched ac outlet on the rear apron.

Laboratory Measurements. The FM usable sensitivity was 10.8 dBf in mono. In stereo, it was set by the stereo/muting threshold of 22 dBf. The 50-dB quieting



Noise and sensitivity curves for FM section of tuner.

sensitivity in mono was 11.8 dBf with 1.6% THD, while in stereo it was 35 dBf with 0.32% THD. The S/N at a 65-dBf input was 84 dB in mono (the highest we have ever measured on an FM tuner) and 72 dB

in most environments the TX-7800 should give nearly perfect FM performance

in stereo. Distortion at that level, with 100% modulation at 1000 Hz, was 0.18% in mono and 0.145% in stereo. Slightly lower distortion could be obtained by holding the tuning knob (to disable the LOCK circuit) and tuning for minimum distortion. Al-

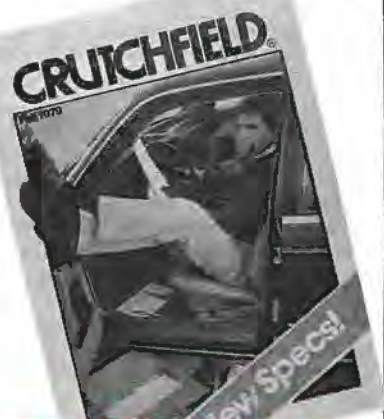
though there is no practical way to defeat the LOCK system, the distortion it caused was negligible.

The stereo-FM frequency response varied less than 0.5 dB overall from 30 to nearly 10,000 Hz, but the output increased slightly to +1.3 dB at 15,000 Hz. Channel separation was better than 34 dB from 30 to 15,000 Hz and about 48 dB through the midrange. The FM capture ratio was 1.38 dB at a 45-dBf input and 1.5 dB at 65 dBf. The respective AM rejection measurements for these signal levels were 60 and 66 dB. Image rejection was 66 dB. Alternate-channel selectivity measured 78 dB, and adjacent-channel selectivity 6.5 dB. The 19-kHz pilot carrier in the output was down 76 dB, and hum was -75 dB.

The only measurements we made on the AM tuner section were of its frequency response. With the wide bandwidth, the response was down 6 dB at 65 and 5600

Performance Specifications

Specification	Rating	Measured
Usable Sensitivity: Mono	9.3 dBf (1.6 μ V)	10.8 dBf (1.9 μ V)
50-dB quieting sensitivity:		
Mono	15.5 dBf (3.3 μ V)	11.8 dBf (2.1 μ V)
Stereo	37.1 dBf (39.2 μ V)	35 dBf (31 μ V)
S/N ratio at 65 dBf		
Mono	83 dB	84 dB
Stereo	79 dB	72 dB
Distortion at 65 dBf (1 kHz)		
Mono	0.05%	0.18%
Stereo	0.08%	0.145%
Capture ratio	1.0 dB	1.38 dB
Alternate-channel selectivity	73 dB	78 dB
Adjacent-channel selectivity	Not specified	6.5 dB
Stereo separation: 1 kHz	50 dB	47 dB
20-10,000 Hz	35 dB	34 dB (30-15,000 Hz)
Frequency response, 20-15,000 Hz	+0.2/-0.5 dB	+1.3/-0.1 dB (30-15,000 Hz re. 400 Hz)
Spurious-response ratio	95 dB	Not checked
Image-response ratio	85 dB	66 dB
I-f-response ratio	100 dB	Not checked
AM-suppression ratio	65 dB	65 dB (at 65 dBf)
Subcarrier-product ratio	70 dB	76 dB
Muting threshold	19.2 dBf (5 μ V)	22 dBf (7 μ V)
Audio output (Level/Z)		
Fixed:	650 mV/4.2 ohms	Not checked
Var:	0-1.3 V/3.6k ohms	0-1.15



FREE Car Stereo Catalog

Get Yours Now!

- 84 pages of photos, comments, and the best possible prices on over 200 car stereo products!
- Dimensions charts, fitting charts, and installation "how-to" articles!
- Only published source of accurate and comparative product specifications!
- The finest brands, including Blaupunkt, Clarion, Craig, Concord, Jensen, Marantz, Motorola, Pioneer, Sanyo, and many more!

Send now for your FREE catalog. We'll rush it to you by first class mail, or if you can't wait, call our toll-free WATS line:

800-446-7924

In Virginia call (800) 552-3961

System of The Month

PIONEER

Pioneer's new KE-2002 in-dash AM/FM cassette car stereo featuring electronic tuning and high fidelity specifications, and Pioneer TS-168 6 1/4" three-way speakers with exponential horns.



Yes! Send me my FREE copy of the famous CRUTCHFIELD Car Stereo Catalog!

Name

Address

City

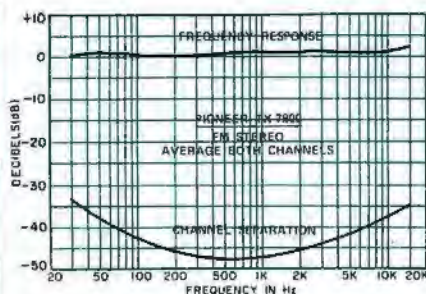
State Zip

CRUTCHFIELD

1 Crutchfield Park, P.O. Caller 1, Department E
Charlottesville, VA 22906

Hz—much better than average. With NARROW bandwidth, the -6-dB frequencies were 130 and 3300 Hz—about average.

User Comment. This tuner had excellent handling characteristics, including a muting circuit completely free of clicks, thumps, and noise bursts. Tuning was easy and noncritical, due to the servo-lock tuning system that effectively overrides adjustment errors. The coupling of the stereo and muting functions on a single switch presents no problems in practice. Any signal too weak to overcome the 22-dBf muting threshold will certainly be too weak for satisfactory stereo.



Average frequency response and crosstalk for both channels.

The AM section was quite good, and people living in low-noise areas may find AM to be a more listenable medium with this tuner than with most others.

In any but the most severe receiving environments, the TX-7800 should be able to provide virtually perfect FM performance. Its least impressive measured parameters fall into the "good" category, with "very good" or "excellent" applicable to most. Emphasis has been placed on utility rather than on "gimmicks" that contribute nothing to the final sound quality. These characteristics, in our view, make the tuner an unusually fine value.

CIRCLE NO. 102 ON FREE INFORMATION CARD



Teac Model 124 stereo cassette deck with Simul-Sync



Teac's new Model 124 "Syncaset" is the first home cassette recorder capable of making "Simul-Sync" recordings.

Available in open-reel recorders from Teac and other companies for some time, Simul-Sync has not been offered in the cassette format until now. This function makes it possible to record a program on one tape track and, while playing it back through headphones, record an accompaniment on the second track in exact synchronism with the first. The two tracks are then heard simultaneously in the normal stereo format during playback.

The 124 is a front-loading, two-head machine with the usual facilities for setting bias and equalization for different tape formulations and a Dolby noise-reduction system. Driven by a single servo-controlled dc motor, the tape transport is mechanically controlled by "piano-key" levers. The recording inputs can be switched to either line or microphone sources, but not both simultaneously. There is a sepa-

rate MIC BLEND feature that can be used to mix the output of a single microphone equally between the two channels while a line source is being recorded.

Overall size is 16 5/16"W x 11 1/4"H x 6 1/4"D (414 x 295 x 156 mm) and weight is 16.5 lb (7.5 kg). Suggested price is \$449.

General Description. All transport-control levers can be operated in any sequence without first pressing STOP, except when going into the record mode. The entire cassette can be seen through the window on the door.

a high-quality
cassette deck
oriented toward
a particularly
unique function

Pressing in the SIMUL-SYNC button removes erase current from the left track of the combined record/playback head to the playback amplifier input. Illumination of the left meter is extinguished at the same time. (The deck has two large illuminated VU meters that are calibrated from -20 to +3 dB with the Dolby reference points at +3 dB.) When the deck is then put into the RECORD mode, recording occurs on only the right channel.

The line outputs of the deck can be monitored through the headphone jack or, preferably, through the headphone output of a separate amplifier, since the deck's own headphone output is at a fixed level. With SIMUL-SYNC engaged, the left-hand channel is heard in the left earcup, while the incoming signal being recorded on the tape's right channel is heard in the right earcup. Since the record and playback head gaps for the two tracks are precisely aligned, the two signals will be fully synced during playback. For some Simul-Sync recordings, a more pleasing playback effect occurs when the channels are partially blended. To allow this, a CROSS-FEED button operates on the recorder's playback outputs.

The MIC jacks are designed for use with microphones rated at 600 ohms or higher impedance. One MIC jack is also labelled BLEND. When recording from a line source, a microphone can be plugged into this jack and a small MIC BLEND control is used to inject an equal amount of its signal into both channels. This feature can also be used in playback, for superimposing voice announcements on a program. On the deck's rear apron are only the line input and output jacks and a DIN socket. The deck also features a built-in MEMORY feature that stops the tape when the counter reaches 000 in the rewind mode.

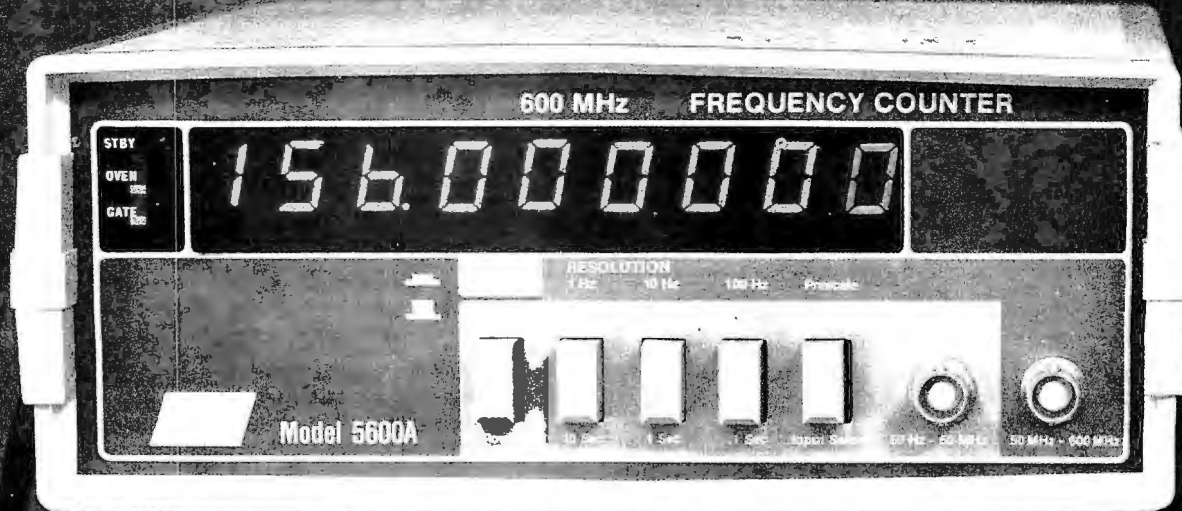
Laboratory Measurements. Our test recorder had been factory adjusted for TDK SA (chrome) and Maxell UD-XL I (normal) tapes, which we used for our tests. A 0-dB recording indication on the meters required a line input of 60 mV and a microphone input of 0.21 mV. The microphone amplifier overloaded at 27 mV.

Playback output from a 0-dB recording was 360 mV with UD-XL I tape and 310 mV with SA tape. The reference 3% third-harmonic distortion level in the playback

DSI HAS DONE IT AGAIN

QUIK-KIT II®

INCLUDES PROPORTIONAL OVEN TIME BASE



WHY BUY A 5600A? Because 98% of the assembly is completed by DSI and you are only one hour away from solving all those difficult bench problems from setting the frequency of a radio signal to within 1/10 of a Hz, to checking the frequency of a 435 MHz mobile radio. Whether you are servicing a VTR, trouble shooting a PLL circuit, the 5600A is the right counter with accuracy that will meet any FCC land mobile, broadcast, or telecommunications requirements. On the bench or in the field the 5600A will do the job you need. The 5600A includes a self contained battery holder providing instant portability or we offer a 10 hour rechargeable battery pack option. Other options include a audio multiplier which allows you to resolve a 1/1000 of a Hz signal and finally a 25db preamplifier with an adjustable attenuator making the 5600A perfect for communications, TV servicing, industrial testing or meeting your QSO on the correct frequency every time.

FACTS ARE FACTS. With the introduction of the 5600A, the only way to beat the competition. This may sound like a bold statement on the part of DSI BUT FACTS ARE FACTS. No counter manufacturer except DSI offers a Full Range 50 Hz to 600 MHz counter with — 9 Digits — 0.1 Hz resolution — 2 PPM 10° to 40° C proportional oven — RF pre-amp — 600 MHz prescaler — three selectable gate times — even ready, standby and gate time indicator lights as standard features — For only \$149.95 kit and \$179.95 factory wired. In fact the competition doesn't even come close unless you consider \$200.00 to \$800.00 close. With DSI having the best price to quality features ratio in the industry, no wonder we've become one of the world's largest manufacturers of high quality frequency counter instrumentation.

FOR INFORMATION — DEALER LOCATION — ORDERS — OEM
CALL 800-854-2049 CALIFORNIA RESIDENTS CALL 800-542-6253

Model	Price	Frequency Range	Accuracy Over Temperature	Sensitivity			Number of Readouts	Size of Readouts	Power Requirements	Size of Unit
				@ 100Hz-25MHz	@ 50-250MHz	@ 250-450MHz				
5600A-K	\$149.95	50Hz-600MHz	Proportional Oven	10MV	10MV	50MV	9	3 inch	*115 VAC or 6.2-14.5 VDC	3 1/2" x 6" x 6"
5600A-W	\$179.95		2 PPM 10° - 40° C							
3550	\$99.95	50Hz-550MHz	TCXO	25MV	25MV	75MV	8	5 inch	*115 VAC or 6.2-14.5 VDC	2 1/2" x 8" x 5"
			1 PPM 17° - 40° C							
500HH	\$149.95	50Hz-550MHz	TCXO	25MV	20MV	75MV	8	4 inch	*115 VAC or 6.2-14.5 VDC or NICAD BAK	2 1/2" x 8" x 5"
			1 PPM 17° - 40° C							

*5600A wired factory furnished in 1 year limited warranty. 5600A kit 90 day limited warranty. Prices and/or specifications subject to change without notice or obligation.

*With AC-9 adaptor.



\$99.95
MODEL 3550K
 1101 Ant. \$3.95
 AC-9 AC Adaptor 7.95
 35P-2 29.95
 Factory Installed 49.95

3550 OWNERS
 You can add the 35P-2, 22 PPM 10° to 40° C proportional oven to your existing 3550



DSI INSTRUMENTS, INC.
 7924 Ronsen Road
 San Diego, California 92111

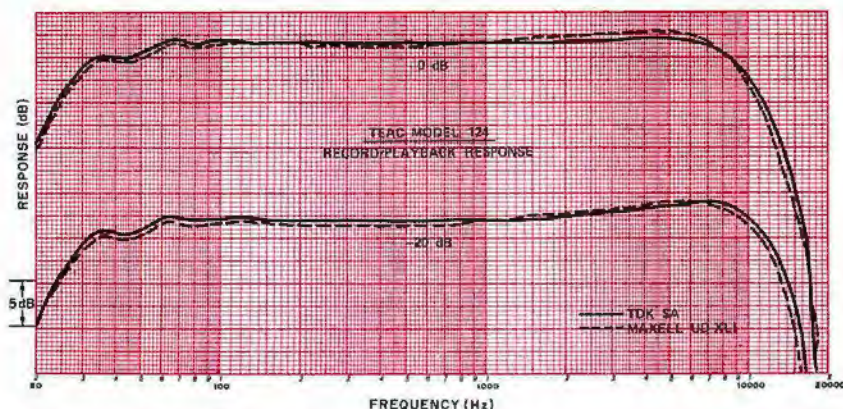
TERMS: MC - VISA - AE - Check - M.O. - COD in U.S. Funds. Please add 10% to a maximum of \$10.00 for shipping, handling and insurance. Orders outside of USA & Canada, please add \$20.00 addition to cover air shipment. California residents add 6% Sales Tax.

CIRCLE NO. 21 ON FREE INFORMATION CARD

5600A Kit \$149.95
5600A Wired 179.95
AC-9 AC Adaptor 7.95
T600 BNC Ant 7.95

BUILT-IN OPTIONS

BA56 Rechargeable 10 Hr. Bat. Pack 24.95
AM56 Audio Multiplier 34.95
1001Hz Resolution 34.95
PA56 25dB Preamplifier with Attenuator 59.95



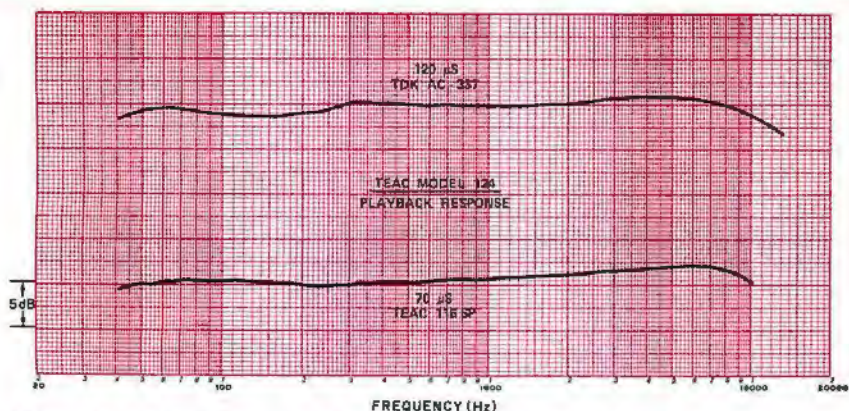
Frequency responses at 0 and -20 dB for two different tape types.

signal was obtained with a recording input of +6 dB with UD-XL I and +3 dB with SA tape. The unweighted S/N ratio referred to those levels was 45 and 41 dB, respectively, for the two tapes. With A-weighting these figures improved to 56.2 and 55 dB. With Dolby engaged and CCIR/ARM weighting, the S/N was about 62 dB with either tape. Through the microphone inputs at maximum gain, the noise increased by 12.5 dB. At a slightly reduced gain, the noise increase was only 3.7 dB.

The meters were calibrated correctly, relative to the standard Dolby level of 200

nW/m, and ballistic response was almost exactly that of a standard VU meter. The tape speed was very slightly fast—about 0.45% at the beginning and 0.3% at the end of a cassette. Flutter, measured with a TDK AC-342 test cassette, was $\pm 0.09\%$ weighted peak (CCIR) and 0.055% weighted rms (JIS). Combined record/playback readings were slightly higher at 0.13% and 0.08%, respectively. In the fast speeds, a C-60 cassette was moved from end to end in 82 seconds in fast forward and 79 seconds in rewind.

Record/playback frequency response



Normal playback equalization at 70 and 120 microseconds.

Performance Specifications

Specification	Rating	Measured
Frequency response	30-16,000 Hz (CrO ₂) 30-13,000 Hz (normal)	31-11,500 Hz ± 2 dB 34-11,000 Hz ± 2 dB
Wow/flutter (NAB)	0.07%	0.055% wrms (JIS) 0.09% w-pk (CCIR)
Signal/noise	55 dB	45 dB normal 41 dB (CrO ₂) unwt'd 56 dB normal A-wtd 55 dB (CrO ₂) 62 dB Dolby/CCIR/ARM
Rewind/fast forward time (C-60 cassette)	90 seconds	82 seconds FF 79 seconds RW
Inputs	60 mV/50k ohms LINE 0.25 mV MIC	60 mV 0.21 mV
Output	LINE 0.3 V/50k ohms PHONES 8 ohms	0.31 to 0.36 V. Volume adequate for 200 ohm phones (fixed level)

was virtually identical with the two tapes at both -20-dB and 0-dB recording levels. At -20 dB, the high-frequency response rolled off a little earlier than in many cassette decks, but there was much less evidence of tape saturation at 0 dB than we are accustomed to seeing. Low-frequency head contour ripples were barely visible. Overall frequency response at -20 dB was ± 2 dB from 31 to 11,500 Hz, relative to the 1000-Hz level. At 0 dB, the response was $+0.5/-1.5$ dB from 34 to 8000 Hz. We measured the 120-microsecond normal playback equalization with a TDK AC-337 tape and the 70-microsecond chrome equalization with a TEAC 116 SP tape. With normal tape, equalization was within $+1/-1.5$ dB from 40 to 12,500 Hz, relative to the 315-Hz level, and with chrome tape, it was within $+2/-0.7$ dB from 40 to 10,000 Hz.

The Dolby tracking was consistent with the measured frequency response. When we measured the response at -20 and -40 dB, both with and without Dolby noise reduction, we noted how the Dolby system inherently exaggerates any departure from flatness in the recorder. Nevertheless, the differences were less than 1.5 dB and usually about 1 dB at all frequencies up to 11,000 Hz.

User Comment. The Model 124 will probably have its greatest appeal to people who have a need for its Simul-Sync capability. This feature is not limited to use in music recordings. Speech therapy, language instruction, and other educational activities often require that a student imitate or respond to a verbal instruction.

The numerical results of our laboratory measurements may seem lackluster compared to the frequency response and dynamic range data from other high-quality cassette decks. However, compensating for any lack of sheer bandwidth is the rather unusual high-frequency overload margin of the Model 124, which is substantially greater than we have found on any other two-head deck. Since one of the chief limitations of the cassette medium is its tendency to saturate the tape at high frequencies, thus dulling or compressing the sound, we put the Model 124 to the additional test of recording interstation FM-tuner hiss and comparing the playback to the original. The differences between the two, at a level of -10 dB, were very minor and much like those we have found in most good cassette machines. When we raised the level to 0 dB (something that one would not ordinarily consider doing with noise on a cassette recorder), playback was still barely distinguishable from the original. The perceived difference was no greater at 0 dB than at -20 dB. Normally, a 0-dB noise recording sounds intolerably dull on playback. S/N performance, also not quite the equal of some other cassette decks, nevertheless met Teac's specification and was adequate for the intended use.

In general, the Teac Model 124 proved itself to be a high-quality cassette deck. It is, clearly, oriented toward performing a particular, unique function. To the credit of the machine, this is accomplished while leaving normal home record/playback performance substantially intact.

CIRCLE NO. 103 ON FREE INFORMATION CARD

The new Heathkit® Hand-held DMM

**-every feature you need
at a GREAT LOW PRICE**



- Measures voltage, current and resistance
- Easy one-hand operation
- Big, easy-to-read LCD display
- Separate voltage and current inputs for circuit protection
- Single PC board for simple, quick assembly

**EASY
ONE-EVENING
KIT ASSEMBLY**
only \$94⁹⁵

Mail Order
Price

Top performance and easy operation make the Heathkit IM-2215 your best buy in a solid-state, hand-held multimeter!

The new IM-2215 brings you features you would only expect in hand-held digital multimeters costing much more! Take measurements with outstanding accuracy - DC voltage, $\pm 0.25\%$ - AC voltage, $\pm 0.5\%$ - DC current, $\pm 0.75\%$ - AC current, $\pm 1.5\%$ and resistance, $\pm 0.25\%$ (basic)! Alternating high-low resistance test voltage makes measuring semiconductors or in-circuit resistance easy! One-hand operation, a large 3½-digit LCD display and built-in calibration references make the IM-2215 ideal for field use. A pivoting stand adapts it to bench use. The low-drain circuitry stretches typical alkaline battery life to 200 hours! Battery condition is monitored, and a LO-BAT indicator warns you of the last 20% of battery life.

You can easily assemble the IM-2215 in just one night, with the help of the clear, concise Heathkit assembly manual. And if you need advice or service, experts are as close as your telephone! It operates on 9-volt battery (not included), or on 120 or 240 VAC with optional cords. The latest technology and traditional Heathkit value is now built into a new hand-held digital multimeter weighing only 14 ounces!

ORDER YOURS TODAY!

For fastest delivery, use the Heathkit Hot Line **CALL (616) 982-3411**

Send to: Heath Company, Dept. 010-580
Benton Harbor, MI 49022

Please send me...

- Heathkit Hand-Held DMM(s) (IM-2215) @ \$94.95 plus \$1.75 shipping and handling each.
- Rugged Leather Carrying Case(s) with Belt Loop for IM-2215 (IMA-2215-1) @ \$14.95 plus \$1.60 shipping and handling each.
- 120 VAC Outlet Cord(s) for IM-2215 (PS-2350) @ \$4.95 plus \$1.75 shipping and handling each.

Total before shipping & handling _____ \$ _____
Michigan residents add 4% sales tax _____ \$ _____
Add shipping & handling _____ \$ _____
Total _____ \$ _____

☐ check ☐ money order ☐ VISA ☐ Master Charge: Code # _____

Acct. # _____ Exp. Date _____

Signature _____
(Necessary to send merchandise)

Name _____
(Please Print)

Address _____

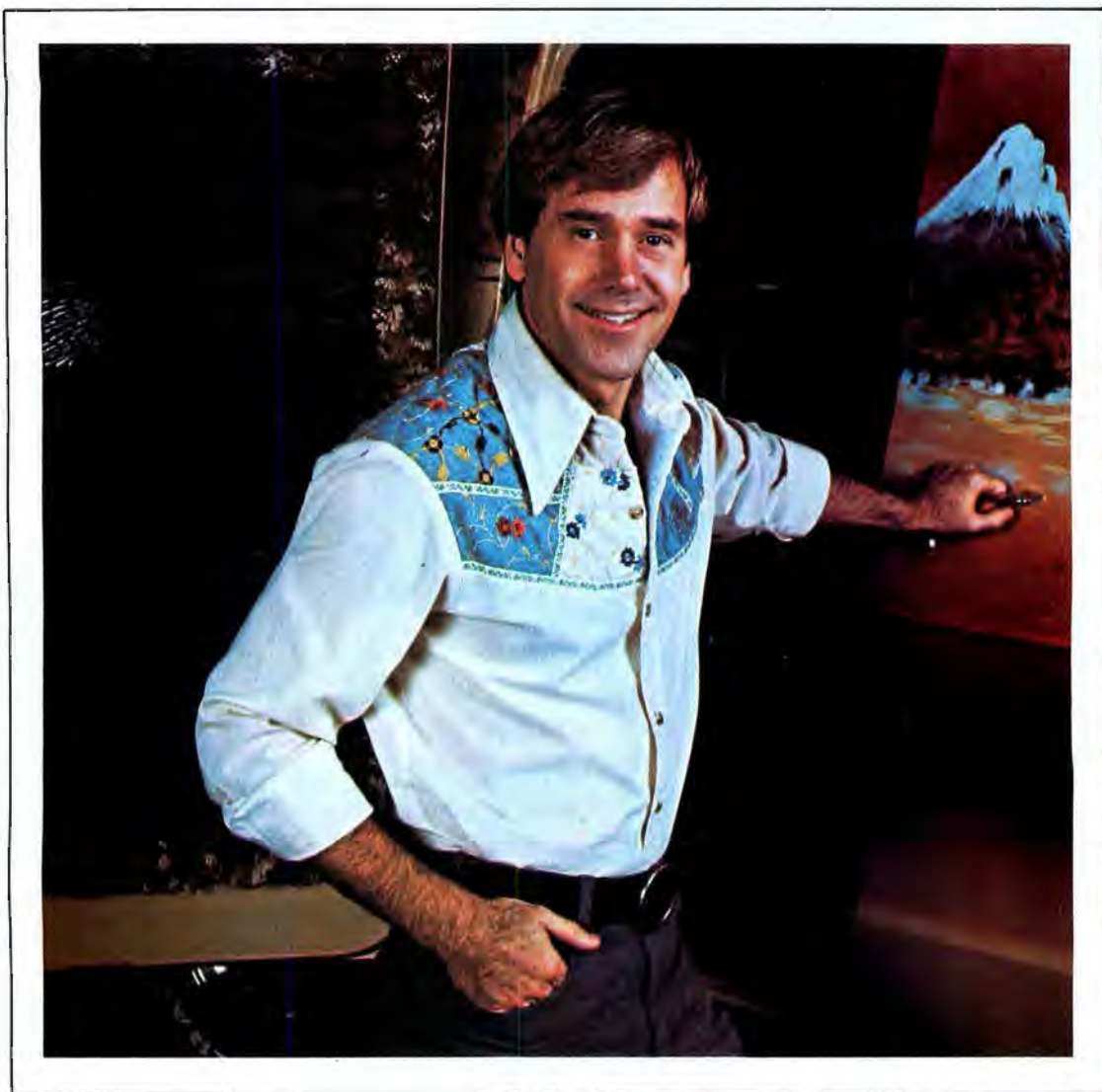
City _____ State _____ Zip _____

Prices are mail order and subject to change without notice. **GX-370**

HEATH
Schlumberger

If coupon is missing, order from:
Heath Company, Dept. 010-580
Benton Harbor, MI 49022

You gotta shop around.



**When you do, you'll probably pick CIE.
You can't afford to settle for
less when it comes to something like
electronics training that could
affect your whole life.**

When you shop around for tires, you look for a bargain. After all, if it's the same brand, better price—why not save money?

Education's different. There's no such thing as "same brand." No two schools are alike. And, once you've made your choice, the training you get stays with you for the rest of your life.

So, shop around for your training. Not for the bargain. For the best. Thorough, professional training to help give you pride and confidence.

* * *

If you talked to some of our graduates, chances are you'd find a lot of them shopped around for their training. They pretty much knew what was available. And they picked CIE as number one.

Why you should shop around yourself.

We hope you'll shop around. Because, frankly, CIE isn't for everyone.

There are other options for the hobbyist. If you're the ambitious type—with serious career goals in electronics—take a close look at what we've planned for you at CIE.

What you should look for first.

Part of what makes electronics so interesting is it's based on scientific discoveries—on ideas! So the first thing to look for is a program that starts with ideas and builds on them!

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson takes one or two principles and helps you master them—before you start using them!

How practical is the training?

This is the next big important question. After all, your career will be built on what you can do—and on how well you do it.

Here are ways some of CIE's troubleshooting programs help you get your "hands-on" training...

With CIE's Experimental Electronics Laboratory...

you learn and review the basics—perform dozens of experiments. Plus, you use a 3-in-1 precision Multimeter to learn testing, checking, analyzing!



When you build your own 5 MHz Triggered-Sweep, Solid-State Oscilloscope you take your first real professional step. You use it as a doctor uses an X-ray machine—to "read" waveform patterns... lock them in... study, understand and interpret them!

When you get your Zenith 19-inch Diagonal Solid-State Color TV you



Pattern simulated.

apply your new skills to some real on-the-job-type troubleshooting! You learn to trace signal flow... locate malfunctions... restore perfect operating standards—just as with any sophisticated electronics equipment!



When you work with a completely Solid-State Color Bar Generator—actually a TV signal transmitter—you study up to ten different patterns on your TV screen... explore digital logic circuits... observe the action of a crystal-controlled oscillator!

Of course, CIE offers a more advanced training program, too. But the main point is

simply this:

All this training takes effort. But you'll enjoy it. And it's a real plus for a troubleshooting career!

Do you prepare for your FCC License?

Avoid regrets later. Check this out before you enroll in any program.

For some troubleshooting jobs, you must have your FCC License. For others, employers often consider it a mark in your favor. Either way, it's government-certified proof of specific knowledge and skills!

More than half of CIE's courses prepare you for the government-administered FCC License exam. In continuing surveys, nearly 4 out of 5 CIE graduates who take the exam get their Licenses!

Shop around... but send for CIE's free school catalog first!

Mail the card. If it's gone, cut out and mail the coupon. If you prefer to write, mention the name and date of this magazine. We'll send you a copy of CIE's FREE school catalog—plus a complete package of independent home study information! For your convenience, we'll try to have a representative contact you to answer your questions. Mail the card or coupon—or write: CIE, 1776 East 17th St., Cleveland, OH 44114.

CIE Cleveland Institute of Electronics, Inc.

1776 East 17th Street, Cleveland, Ohio 44114
Accredited Member National Home Study Council

☐ **YES...** I'm shopping around for the **right** kind of career training in electronics troubleshooting—and CIE sounds well worth looking into. Please send me my FREE CIE school catalog—including details about troubleshooting courses—plus my FREE package of home study information!

PE-99

Print Name _____

Address _____ Apt. _____

City _____

State _____ Zip _____

Age _____ Phone _____

(area code)

Check box for G.I. Bill information:
☐ Veteran ☐ Active Duty

Mail today!

JBL'S NEW L150: ITS BOTTOM PUTS IT ON TOP.

JBL's new L150 takes you deeper into the low frequencies of music without taking you deeper into your budget.

This short-tower, floor-standing loudspeaker system produces bass with depth, power and transparency that comes incredibly close to a live performance.



A completely new 12" driver was created for the L150. It has an innovative magnetic assembly, the result of years of research at JBL. It

uses a stiff, heavy cone that's been coated with an exclusive damping formulation for optimum mass and density.

And it has an unusually large 3" voice coil, which aids the L150's efficiency and its ability to respond to transients



(peaks, climaxes and sudden spurts) in music.

There's even more to the L150's bottom—a 12" passive radiator. It looks like a driver but it's not. We use it to replace a large volume of air and contribute to the production of true, deep bass. Bass without boom.

If you're impressed with the L150's lows, you'll be equally impressed with its highs and mids. Its powerful 1" high-frequency

dome radiator provides wide dispersion throughout its range. And a 5" midrange transducer handles high volume levels without distorting. The maximum power recommended is 300 watts per channel.

The L150's other attributes include typical JBL accuracy—the kind that recording professionals rely on. Maximum power/flat frequency response. High efficiency. And extraordinary time/phase accuracy.

Before you believe that you can't afford a floor system, listen to an L150. While its bottom is tops, its price isn't.

James B. Lansing Sound, Inc., 8500 Balboa Boulevard, Northridge, CA 91329.



**FIRST
WITH THE
PROS.**



25TH
ANNIVERSARY
ISSUE

An inexpensive solid-state controller that reduces inefficiencies in electric motors such as those used in refrigerators and dishwashers has been developed at the NASA Marshall Space Flight Center (by Frank J. Nola). Since total electric energy consumed by motors in the U.S. is equivalent to six-million barrels of oil per day and

25% or more of this electricity is pure waste in the form of heat and other factors, the discovery's import is obvious.

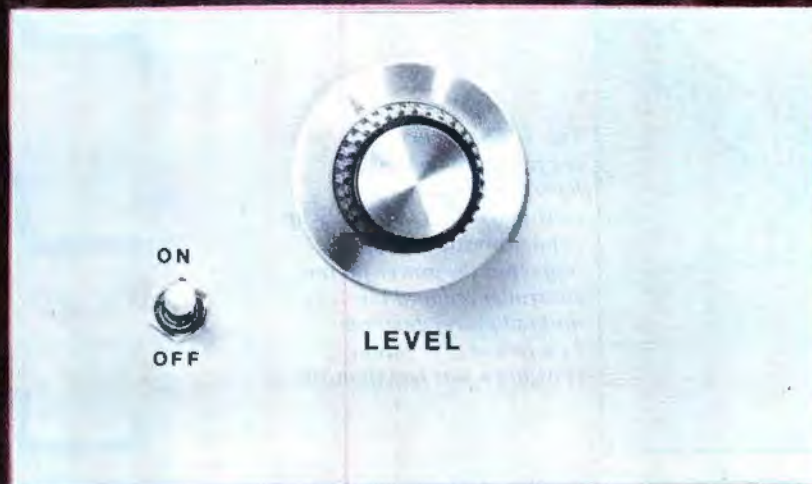
In keeping with our tradition of publishing significant new developments as construction projects, POPULAR ELECTRONICS is especially pleased to present plans for building this under-\$30 device in its 25th anniversary issue.

(Continued overleaf)

BY MYLES H. MARKS

EXCLUSIVE PROJECT!

NASA Motor-Control Circuit Cuts Electric Cost...



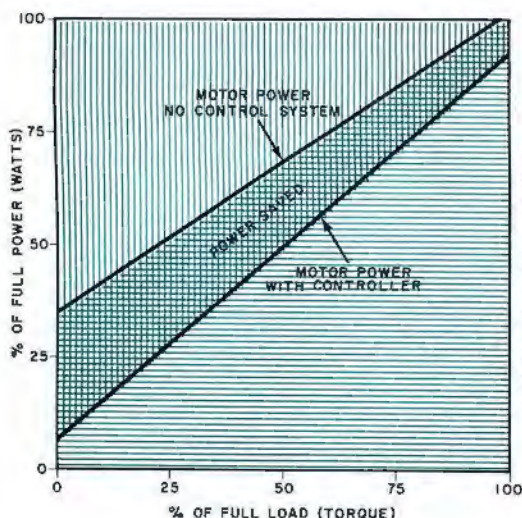
Motor-Control Circuit Cuts Electric Cost...

continued

The NASA-developed controller is meant to work with ac induction motors, probably the type most widely used today. They characteristically run at a nearly constant speed that's fixed by power-line frequency and independent of load and supply voltage. When heavily loaded, the motor draws line current that is nearly in phase with the applied voltage, keeping its power factor (cosine of the angle between current and voltage) high and developing a large torque. Under light load conditions, the motor develops less torque by allowing more lag between the voltage and current. This reduces the power factor while leaving the current essentially the same in magnitude.

Though the low power factor means that conversion of electricity to mechanical power is small, the large current during the supply lines and motor windings. This is what reduces efficiency. To minimize this waste, Nola's device monitors the motor's power factor and, when it detects light load conditions, it reduces the supply voltage. This increases "slip" in the motor, which causes a speed reduction of 2% or less so that the motor acts as if it were heavily loaded.

The current, now more nearly in phase with the voltage, therefore does as much useful work as before, but it and the voltage are smaller, resulting in a net saving of electric power.



Power Savings. The device was tested at Marshall Center on over 40 types of motors. Power savings ranged to 60%, depending on the loading. Up to 40-50% power reductions are claimed for motors running lightly or intermittently loaded.

The savings derived by using the controller with motors driving relatively constant loads (refrigeration systems and pumps, for example) are smaller, since the device can then do little more than reduce the 8-10% safety factor allowed for low-voltage conditions. On the other hand, since such motors typically have long duty cycles, significant economies may be realized over a period of time.

Figure 1 was constructed from data averaged from tests made on a 1/3-hp split-phase motor, and 1/4- and 3/4-hp capacitor-start motors. The top curve shows the typical power required for various loads when no control system is used. The lower curve shows the power consumed when the power-factor controller is used. The controller reduced the no-load power drain by a factor of 5 or 6 and increased the power factor from 0.2 to 0.8. In all three motors, the speed reduction resulting from lower voltage was less than 2%.

Circuit Operation. The circuit shown in Fig. 2, which is a simplified version of the original invention, operates in exactly the same manner. Also shown in Fig. 2, facing the diagram are waveforms for the corresponding letter-in-a-circle points on the schematic.

Typically, current may lag the voltage by 80° in an unloaded motor and only 30° when loaded. The controller continuously monitors phase angle between voltage and current, producing a voltage proportional to that phase angle. This

voltage is summed with a preset reference voltage that corresponds to a desired phase angle. The difference between the two produces an error signal that biases a ramp voltage synchronized to the 60-Hz line voltage.

The intersection of the ramp and the error voltages is detected by a squaring amplifier whose output provides proper timing for controlling a triac in series with the motor. The triac is triggered at a point during the cycle, and the circuit switches to "off" as the line current goes through zero. Triggering the triac earlier in each half cycle raises the average voltage to the motor and vice versa.

(Continued on page 42)

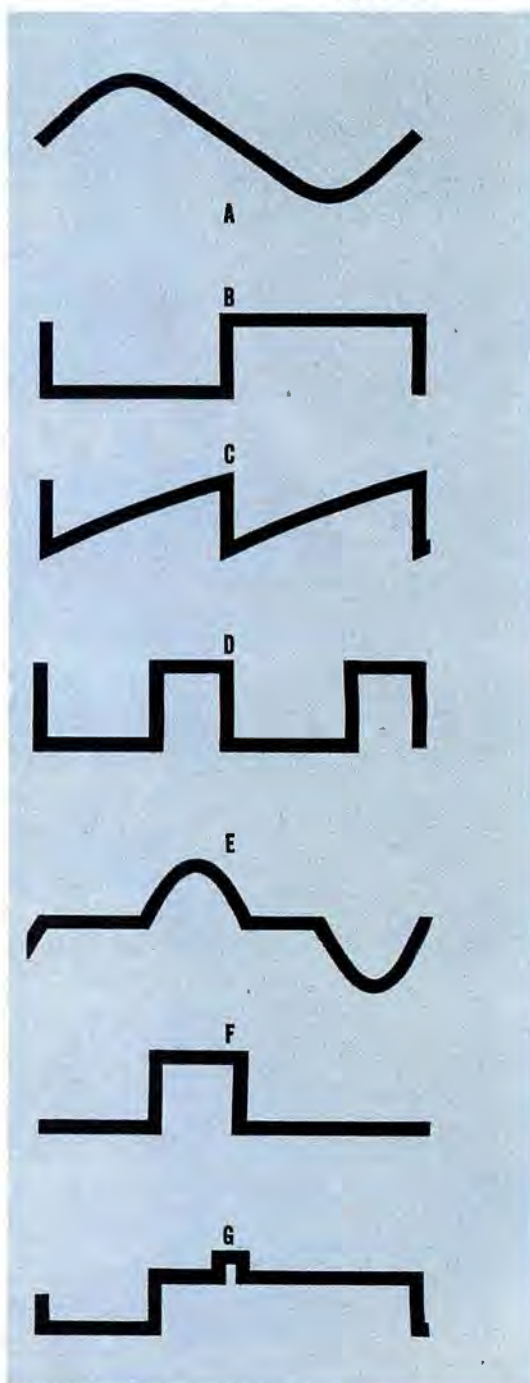


Fig. 1. These curves are the results of tests made by NASA on a 1/3-hp split-phase and 1/4- and 3/4-hp capacitor-start motors. Note that the power-factor controller reduced the no-load power demand by a factor of 6. Motor slowdown was less than 2%.

PARTS LIST

C1—1- μ F non-polarized capacitor, Mouser Electronics 19NK001 or equivalent
 C2—4.7- μ F, 20-V electrolytic
 C3—6.8- μ F, 20-V electrolytic
 C4—0.25- μ F, 400-V capacitor
 C5, C6—470- μ F, 35-V electrolytic
 C7—2.2- μ F, 20-V electrolytic
 C8, C9—0.033- μ F capacitor
 C10—0.33- μ F capacitor
 D1, D2, D9—1N4148 or 1N914
 D3 through D6—1N4001 or similar
 D7, D8—1N757, 9.1-V, 400-mW zener
 IC1—Quad 741 op amp, LM324N
 Q1, Q2, Q3—2N2222 or similar
 Q4, Q5—2N2907 or similar
 Following are $\frac{1}{4}$ -watt, 5% resistors unless otherwise specified:
 R1—0.02 ohm, 5 W (see text)
 R2—620,000 ohms (see text)
 R3, R18—39,000 ohms (see text for R3)
 R4—1800 ohms (see text)

R5—3300 ohms (see text)
 R6—1.5 megohms (see text)
 R7—100 ohms, 2 W (see text)
 R8—51 ohms, 1 W
 R9, R13—1000 ohms
 R10, R20—3000 ohms
 R11, R12, R23, R24, R25—27,000 ohms
 R14, R29—9100 ohms
 R15—15,000 ohms
 R16—68,000 ohms
 R17—150,000 ohms
 R19—1 megohm
 R21—200 ohms
 R22—91,000 ohms
 R26—36,000 ohms
 R27, R28—5600 ohms
 R30—20,000-ohm linear taper pot. (see text)
 S1—Spst switch
 T1—20-V CT, 0.3-A secondary (115/220-volt version is Signal DP-241-4-20 or similar)

Triac—200-V, 15-A (400-V unit for 220-V operation is available. See note below.)
 Misc.—Suitable enclosure, heavy-duty ac line cord (male and female connectors), mounting hardware, etc.
 Note—The following are available from M. H. Marks Enterprises, 315 Thornberry Ct., Pittsburgh, Pa 15237: Kit of all components for 115-V system including triac and pc board, cabinet, line cord and ac socket or 220-V version including 115/220-V transformer and 400-V triac, without cabinet, line cord and chassis socket for \$29.95 plus \$3.00 postage and handling; or 115-V version excluding cabinet, line cord and ac socket at \$24.95 plus \$2.50 postage and handling. Also available separately: Etched and drilled pc board at \$7.95 postpaid. All sales to U. S. A. only. Pennsylvania residents, please add 6% sales tax. Allow 6–8 weeks delivery.

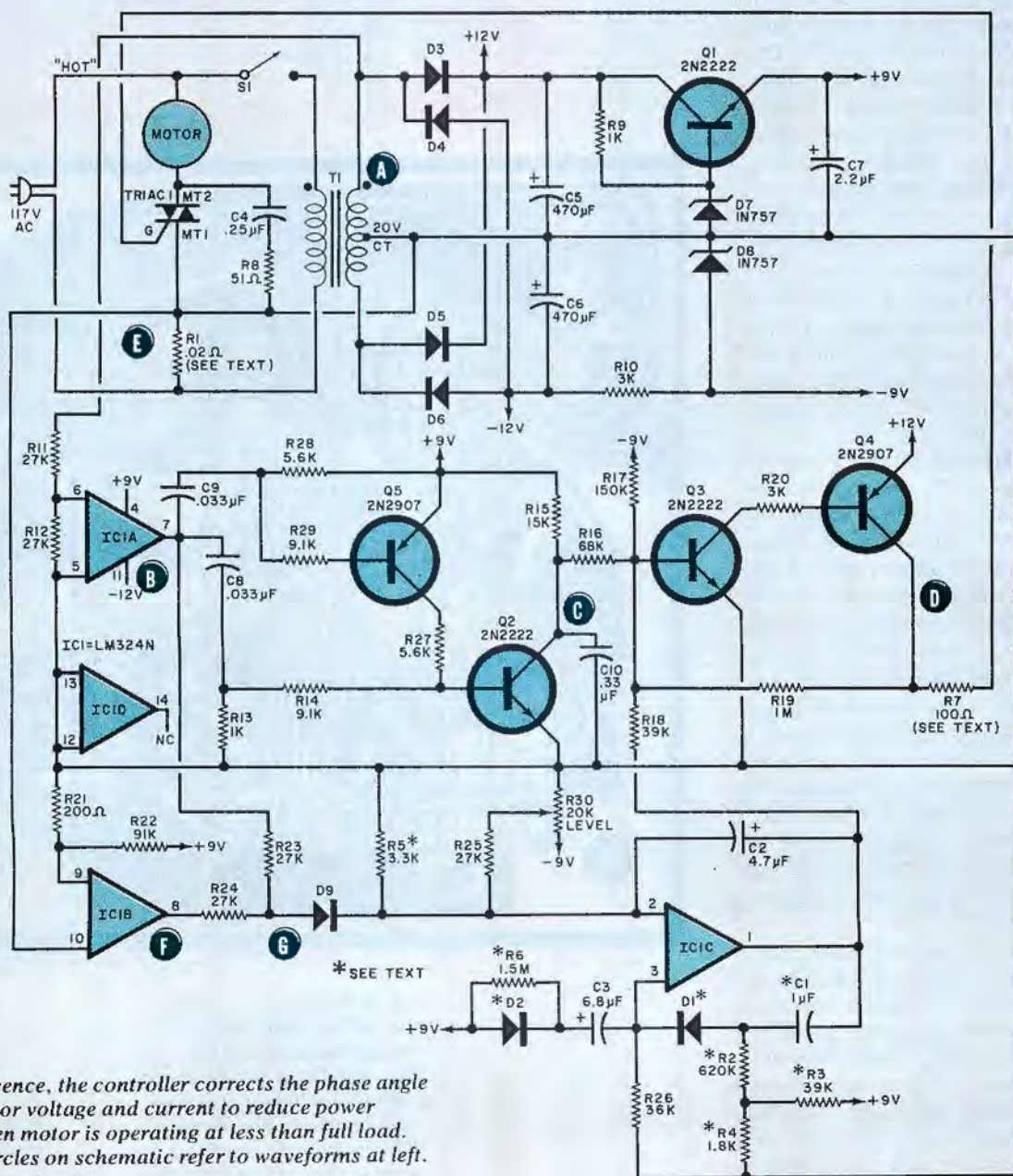


Fig. 2. In essence, the controller corrects the phase angle between motor voltage and current to reduce power required when motor is operating at less than full load. Letters in circles on schematic refer to waveforms at left.

Motor-Control Circuit Cuts Electric Cost...

continued

The triac's control signal is created by sensing the voltage (A) developed at the top end of transformer *T1*—which also serves as the power source for the conventional dc supply. (Note how the secondary of *T1* is phased with the primary ac power.) The voltage is applied via *R11* to the input of op-amp *IC1A*. Since this op amp is operating at full gain, the output is a square wave at power-line frequency. This IC has two outputs (B). One, via *C8* and *C9*, drives the ramp generator, which consists of *Q5*, *Q2*, and associated components. Capacitor *C10* charges through *R15* to form the ramp. The positive-going step from *IC1A* turns on *Q2*, thus rapidly discharging *C10* to complete the ramp function. The negative-going step from *IC1A* turns on *Q5*, which, in turn, causes *Q2* to saturate, thus discharging *C10*.

Since *IC1A* is triggered at power-line rate, the ramp generated across *C10* is synced to the power line, with each ramp occupying a half power-line cycle. The other output of *IC1A* is coupled through *R23* to diode gate *D9*.

A voltage proportional to the current through the motor (E) develops across sensing resistor *R1*. This voltage is passed to *IC1B*, whose squared-off output (F) is passed through *R24* to diode *D9*, where it combines with the output of *IC1A* to make waveform (G). The summed voltage at the cathode of *D9* is differentiated and fed to integrator *IC1A*, along with a dc control level determined by LEVEL potentiometer *R30*. This control is used to set the motor's optimum phase angle. Time constant network *C3* and *R26* provide a delay to let the motor develop maximum torque when first turned on. Capacitor *C2* provides the high-frequency roll-off necessary for system stability.

Since suddenly applied loads may cause the motor to stall if the system reacts too slowly, the circuit contains some components to prevent this from happening. These parts, which alter the integrator's time constant, are shown with an asterisk in Fig. 2 (*R2*, *R3*, *R4*, *R5*, *R6*, *D1*, *D2*, and *C1*). If you do not need this capability, eliminate these components and tie the positive end of

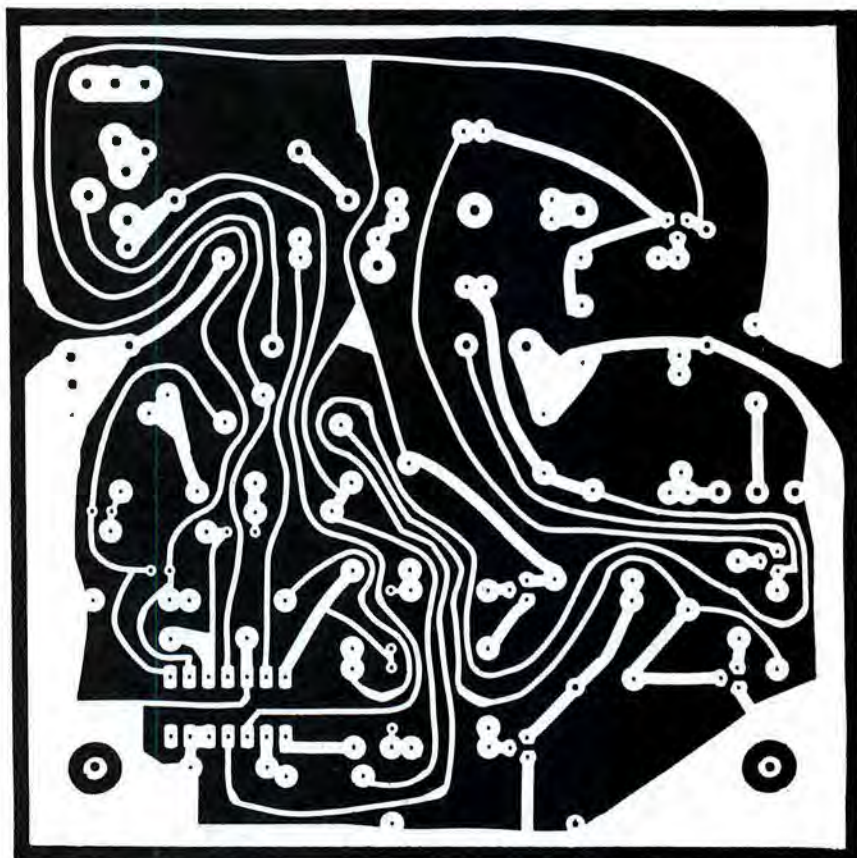
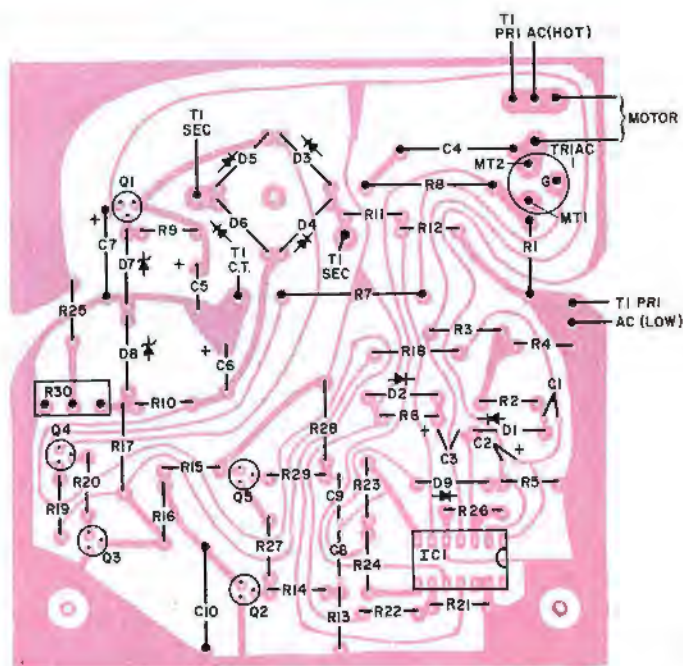


Fig. 3. Actual-size etching and drilling guide for a printed-circuit board for the controller is shown above. Component layout is at top. Note that there are several different options regarding components and construction, as outlined in text and Parts List.

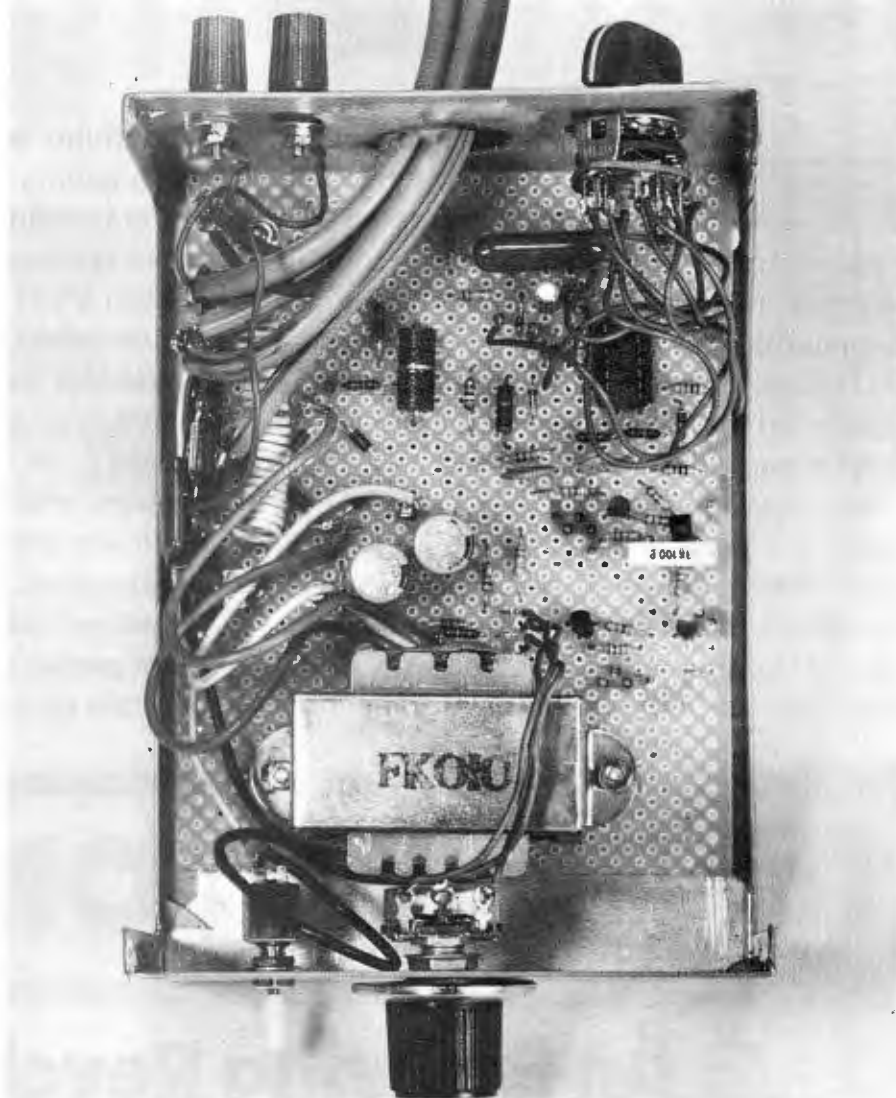
C3 to the +9-volt line by replacing R6 with a jumper. The IC1C output signal is coupled through R18 to the Q3 input, in parallel with the ramp from C10.

Triac controller Q3-Q4 is normally biased off by R17. When the composite signal (ramp plus pulse) arrives at the base of Q3, this transistor will turn on when the peak of the composite signal overcomes the bias. Since the ramp level is fixed, the pulse from IC1C, controlled by R30, determines when the Q3-Q4 combination turns on. When turn-on occurs, the waveform shown at (D) triggers the triac, thus applying voltage to the motor.

Construction. The circuit can be most easily assembled on a pc board using the foil pattern and component layout shown in Fig. 3. A bridge rectifier can be used in place of the four rectifier diodes (D3-D6). If a 24-volt transformer is employed, increase the value of R7 to 150 ohms. Resistor R1 can be fabricated from a 9" length of #22, or a 6" length of #24 solid copper wire that's wound on an insulated support dowel.

At this time, you make the decision about the aforementioned possibility of sudden or clutched-in loads that would require using the asterisked components. Furthermore, if this device is to be used with motors requiring in excess of 300 watts, to prevent damage to the triac or pc board, remove the triac, R1 and the ac input from the board, mounting a terminal strip in their place. Mount the triac with R1 to the chassis or optional heat sink (suitably isolated) and wire them into the circuit board, using the terminal strip. Make sure that the "low" side of the ac line is used as the circuit common, and use polarized plugs for all ac-power connections. *Do not use the metal chassis as the common ground!* Failure to observe these precautions may cause a serious shock hazard.

Mount the pc board and transformer in a chassis, securing the board on insulated spacers so that no part of the ac line makes contact with the chassis. If desired, LEVEL potentiometer R30 can be removed from the pc board and a conventional rotary potentiometer of the same value can be mounted on the chassis. The motor can be plugged into an optional socket mounted on the chassis (wired to the motor-connector pads on the pc board), or use a suitable length of heavy-duty ac line cord having a socket at one end. Do not forget to use ac line cord having sufficient current-carrying capacity to handle the load.



Photograph of the author's prototype which was built on perf board, though a printed circuit board is recommended. The binding posts and switch on the rear were used for testing during design.

Since many of the systems to which the controller can be usefully applied have motors fed from 220-volt ac mains, you may wish to adapt the circuit to work at that voltage. This can be done by exchanging T1 for a similar transformer with twice as many primary turns and substituting a higher voltage triac (400 PIV minimum). Both "hot" legs of the 220-volt line should be isolated from the chassis, while the center tap should be connected to the ground circuit. An appropriate line plug and receptacle can be used, or the controller can be hardwired to the load.

Use. Plug the power-factor controller into an ac outlet and connect the motor to be controlled. Turn both on. With the motor operating, slowly adjust LEVEL control R30 until a slight drop in speed or mechanical power is noticed. Vibration, too, will probably diminish. Slightly back off on R30 until you feel the point where the speed barely drops off. This

should be the optimum setting of the controller. It will probably be necessary to readjust R30 for each different motor you wish to control.

As noted earlier, the savings effected by using the power factor controller (and the length of time required for the device to pay for itself) depend on the way in which a particular motor is loaded and for what proportion of the time it is in use. Clearly, intermittently used appliances such as power tools are poor candidates. In most households, refrigerators, air conditioners, ventilating fans, swimming-pool pumps, and other machines that run for extended periods will let the power factor controller pay for itself more quickly than smaller and/or intermittently used appliances. Savings will depend on your electric rates, too. In New York City, where one kilowatt-hour costs 11.5 cents in the summer and 9.52 cents in the winter, the controller, used on a 16-cu-ft frostfree freezer, might well pay for itself in about two years. ◇

It was only a few short years ago that engineers became increasingly interested in what might well become the most significant advance in semiconductor technology since the invention of the transistor—the single-chip microcomputer. It has stimulated interest in electronics to levels seldom before experienced.

Yet relatively few people truly understand the impact of the “computer-on-a-chip.” Microelectronic technology moves so rapidly that it becomes impossible for even those intimately involved with a new development to grasp its full significance.

Something new to divert the attention always seems to evolve. But without some understanding of the depth and scope of these technological changes, potential users too often perceive them as added confusion rather than practical innovations.

Webster defines the word *evolution* as the “art of unfolding or unrolling . . . a process of development, formation or growth.” *Revolution* is defined as a “complete and drastic change of any kind.” Understanding the “evolution” of these “revolutions” will help place future development possibilities into a more readily discernible perspective.

The MICROCOMPUTER

An Evolving Revolution in Consumer Electronics

BY JAMES T. VAN TASSEL

Texas Instruments Inc.

It's November 1, 1954, fully 25 years ago. A remarkable new invention has just been announced that will lead innumerable people—young and old alike—to seemingly plug their ears with a small, handheld device. This “earplug” isn't designed to solve auditory problems, but it will start a revolution in personal communications and help make “solid-state” a household word.

The First Revolution. The innocuous hand-held device alluded to was the first transistor radio. Blaring out such hits as “Rock Around the Clock” or Elvis in his “Blue Suede Shoes,” this transistor radio represented the first volume application of the germanium transistor invented six years earlier by Bell Labs.

Transistor prices had dropped from \$16.00 to \$2.50.

Another major breakthrough in transistor technology had been announced six months earlier. At a meeting of the National Conference of Airborne Electronics in May, Gordon Teal of Texas Instruments was next to last on the agenda. The title of his presentation was “Some New and Recent Developments in Germanium and Silicon.” Not sensing the impact of the subject, one speaker after another predicted that the tech-

nology for producing silicon crystals of sufficient purity for semiconductor manufacture was years away. Teal said, stunning his audience: “Contrary to popular belief about the prospects for the silicon transistor, I happen to have a few here in my pocket.” The last speaker of the day lost his audience as they clamored en masse to the rear of the hall for literature on the new devices.

These two seemingly different events heralded the first revolution in solid-state electronics. Not only had the transistor

(continued on page 46)

Development of the single-chip microcomputer, such as the TMS1000, has led to the establishment of entire new product areas such as electronic toys and games, a variety of programmable appliances, and sophisticated automatic scanners.



Evolving Revolution

continued

been mass-produced, the temperature problems inherent in germanium had been solved through the use of silicon. This opened the way for the fledgling aerospace industry to explore alternatives to the large, overly expensive and unreliable vacuum-tube systems that had encumbered aircraft since before World War II.

The Second Revolution. In November of 1958 Jack S. Kilby, who had only joined TI about six months earlier, demonstrated a unique semiconductor that for the first time incorporated more than one transistor, resistor and capacitor on a single chip of silicon. The integrated circuit eliminated the need for masses of separate discrete devices and the multitude of electromechanical interconnections they required. It has thus paved the way for a host of consumer products that were less costly and more reliable.

The first production integrated circuits delivered to the Air Force in 1962 were simple devices with two to four Active Elements Groups (AEGs) per package, priced at \$100 each in small quantities. An AEG is a measure of circuit complexity defined as one digital logic gate, a single bit of memory or a single stage of amplification.

Commercialization of this revolutionary technology led to an increasing number of AEGs being packed into a rapidly shrinking area. For comparison, a vacuum-tube AEG of the mid-1950's occupied about four square inches. The transistor AEG of the early 1960's occupied only three-fourths of a square inch. Progressing from Small-Scale Integration (SSI) through Medium-Scale Integration (MSI) with over 100 AEGs per chip to Large-Scale Integration (LSI) with over 1000 AEGs per chip, the typical active element group was reduced to two and one-half millionths of an inch. Cost dropped also from \$7.00 per AEG in 1960 to less than \$0.001 currently.

One of the major developments that contributed to the development of LSI technology was the change from a concentration of bipolar devices to a unipolar configuration called the Metal-Oxide-Semiconductor, or MOS. With bipolar devices, high component densities were

very difficult and chip sizes were limited because of problems with heat dissipation and low product yields. MOS technology, where only one type of current carrier is used as opposed to two, offered the higher packing densities, lower power consumption and fewer machine steps. However, it did so at the expense of throughput speed.

Among the outgrowths of this advanced MOS/LSI technology was the hand-held calculator invented in 1967 by Jack Kilby, Jerry Merryman and the author. Measuring only $4\frac{1}{4} \times 6\frac{1}{8} \times 1\frac{3}{4}$ inches, this first miniature calculator had as its working heart an integrated-circuit array that contained all of the necessary electronics for performing addition, subtraction, multiplication and division.

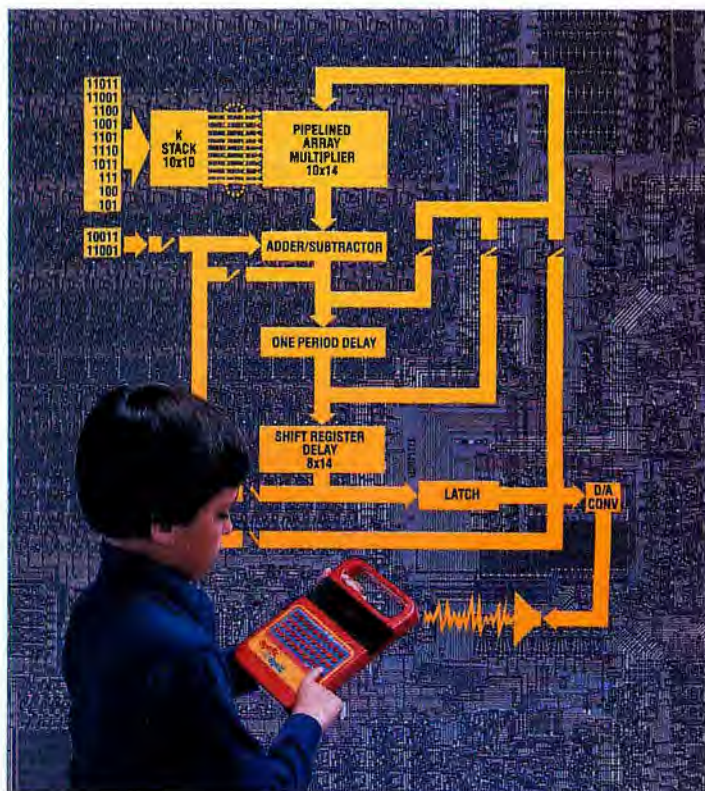
PMOS (Positive-channel MOS) technology and demand for low-cost calculators led a number of companies to undertake development of a calculator chip. Intel Corporation was among those that chose to design a versatile, programmable single-chip microprocessor, one element of a multi-chip microcomputer system. Introduced in 1972, the Intel 4004 processed data blocks of 4 bits each. Less than a year later, National Semiconductor, Rockwell International, and Fairchild Semiconductor also en-

tered the marketplace with microprocessors capable of processing 8 bits and containing anywhere from 5000 to 10,000 transistors.

For the purposes of definition, the microprocessor is the basic CPU—Central Processing Unit—of a computer. When memory, clock and input/output circuits are added, the system becomes a microcomputer. With software, a power supply, interface devices, control and a display capability, the configuration becomes a microcomputer system that operates like a true computer.

The Third Revolution. The next revolutionary step in microelectronic technology was taken in early 1971 when Michael Cochran and Gary Boone of Texas Instruments developed the single-chip microcomputer. There were over 20,000 transistors and other components comprising all of the elements of a computer on a chip of silicon a few thousandths of an inch thick and less than one-fifth of an inch square. Component count was reduced from about 10 to only 1 with system costs reduced from about \$150 or \$200 for a comparable microprocessor or custom LSI system to less than \$5.00 currently.

This tiny computer-on-a-chip offered



Superimposed over the photomicrograph of the TMC0280 Speech Synthesis chip is block diagram of linear predictive coding-based system used in TI's Speak and Spell.

4-bit computational power to help execute automatically a wide array of complex operations. On board the chip there are: (1) the arithmetic and logic unit (ALU) that performs basic decision-making and data processing, (2) memory for storing both computer software instructions and input data that the computer manipulates or processes, (3) control and clock circuitry for retrieval of instructions from memory and directing the rest of the system to execute these instructions in proper sequence and timing, and (4) input/output subsystems that allow the computer to productively communicate with the outside world.

During the processing of the silicon slice, the software program generated from the end system's functional specifications is imbedded in memory by a single-level mask technique that programs three parts of the microcomputer—the ROM, the instruction decoder and output encoder. These programmed parts control data input to the central processing unit, the processing of the data, and the encoding of the output to meet the needs of the system. Electronic elements in the microcomputer are reduced to micron dimensions so that an enormous amount of task-performing power is packed into an area of 1/20 of a square inch. What is truly significant is not so much that such a high degree of miniaturization is achieved, but that substantial economies of manufacture have been realized both for the electronics and the end-systems, along with substantial increases in reliability. For example, a current family of four series of 4-bit devices that have evolved from the original microcomputer offers a reliability of more than 0.05% per 1000 hours. This equates to less than one failure per 210 years. And the cost is \$1.75 or less in high-volume production quantities.

With a cost and reliability impact of more than 15 to 1 over microprocessor and hard-wired LSI systems, the microcomputer is revolutionizing digital electronic control. The most obvious impact has been in consumer electronics, where entirely new product lines are technically and economically feasible.

The transistor radio of the 70's now offers automated frequency scanning coupled with digital readout.

The calculator now performs a full array of scientific and engineering functions at a retail price more than 90% less than it was just a few years ago.

Microwave ovens have been made programmable through the use of the microcomputer, as have washing ma-

chines, blenders, food processors, automotive systems, TV tuners, security systems, and even children's toys.

In a very real sense, the microcomputer has brought what has long been perceived as science fiction into the realm of science fact. The microcomputer, the microprocessor and custom LSI logic are all the result of extremely rapid technological progress that continues to be made within the semiconductor industry. And there is every reason to believe that this is just the beginning; that the complexity will increase in direct proportion to the reduction in cost.

Where Do We Go From Here? If the past decade can be any indication, the future possibilities are virtually unlimited. They're difficult to predict in specific terms, however, because technology is snowballing in a way that few people could have foreseen only a few short years ago.

The toy industry is a good example. The microelectronics revolution has hit the toy business harder than anything since batteries replaced wind-up mechanisms a generation ago. In the beginning, manufacturers were somewhat timid about getting into the area of electronic playthings. Toys are a big, serious business, and overnight failures and fortunes are common. However, when a few toy companies cautiously came out with their first electronic games in 1977, the market subsequently exploded.

Not even the most optimistic of industry observers could have foreseen the blockbuster success of the electronic toy and game products of 1978, which were sold out virtually overnight. In just three years, the market has jumped from \$21 million in 1977 to \$152 million in 1978 with a projected \$225 million in 1979, according to the Toy Manufacturers of America. Some predict the market will hit \$500 million in 1980 and that eventually most games will become electronic.

As with the toy business, the speed with which innovation spreads makes it virtually impossible to predict accurately the impact of the microcomputer on other consumer products and services. However, certain trends are beginning to emerge which give a generalized indication of coming developments.

Much of what has happened over the past few years represents a relatively simple adaptation of calculator technology, the addition of touch-panel or keyboard-based electronic control to existing products. Recently, however, entirely new concepts have been developed;

new consumer and commercial products are available that would not be practical or even possible, in some cases, without the microcomputer.

The digital thermometer is one such product. A very simple semiconductor, the thermistor, is used to measure the change in resistance caused by the change in temperature. However, the change in resistance for either negative or positive temperature coefficient thermistors follows a complex curve that can be almost logarithmic in shape. It is possible to select a narrow range for health-care applications, as an example, and then add various shunt resistors to linearize the curve. The linear signals can then be converted to a digital readout, but this limits the application of the thermometer and tends to price it out of the commercial market.

A far more cost-effective answer is being carried out by Electro-medics, Inc. of Denver, Colorado. There, designers put the algorithm that defines the temperature-resistance curve into the microcomputer and then use it to solve analog-to-digital computations. The result is a broad-range thermometer that can serve a multitude of applications with an accuracy of 0.1 degree. So because of the microcomputer, it is possible to take a patient's temperature in one-tenth the time, with greater accuracy, without the cost of breakage, and without the human error that was always inherent in a technician's attempting to read a glass thermometer.

A new toy organ recently introduced by Kenner Products of Cincinnati, Ohio, exemplifies another type of product made possible by the microcomputer. Using a TMS1000 4-bit single-chip microcomputer, the Play 'N Playback organ allows preschoolers to hear any of eight songs programmed into memory played out, to play songs of their own composition, and to record and then play back those songs or others from the accompanying songbook in proper sequence and rhythm.

For those that have long been associated with mechanical and electromechanical buzzers, bells and whistles, the concept of a tiny piece of silicon talking back or making music seems incomprehensible. In the past, where sound effects have been essential, discrete semiconductors have provided a limited variety of sounds. The products, however, suffered from the variations between individual discrete components and the high costs involved in development, assembly and packaging.

(continued on page 48)

Evolving Revolution

continued

Custom integrated circuits to generate sound effects were not an attractive alternative because of the lack of external programming capability. If the sound was not correct or even quite accurate, the circuit had to be redesigned. The original was simply a wasted effort. Another major problem with custom sound circuits was that they were limited to only one application, thus necessitating large-volume orders to amortize development costs.

The microcomputer was the technological breakthrough that opened the door to the low-end sound generator market. It can be used independently or to control a variety of sound generator circuits. By itself, the microcomputer can only produce square waves by holding an output ON for a short period and then holding it OFF for an equal period. This creates a square-wave cycle which, for most low-end applications, is of acceptable sound quality. For purer tones, as in musical instruments, the square waves can be shaped outside of the microcomputer quite simply by adding a

resistor and capacitor to the output.

Musical tones are not the only type of sound that can be generated through the microcomputer. The new Marx Electronic 300 Bowling Game™ is a microcomputer-controlled table-top game that creates the sights and sounds of a real bowling alley. The 4-bit microcomputer brain of the game drives incandescent lamps to represent bowling pins and LED displays to indicate the score. In addition, it receives inputs from fourteen switches strategically placed in the alley surface and controls outputs to a sound circuit to imitate the sound of pins falling. This is achieved by generating a low-frequency tone and then decaying the sound through external components. The falling-pins effect is made by stringing several of these sounds together to represent a number of pins being hit.

For applications requiring more complex sounds or those of higher frequencies, the microcomputer can be used to provide the control signals for a complex sound-generator chip to produce sirens, whistling missiles, explosions, chirping birds, and a host of other sound effects. More advanced chips can produce truly complex sounds composed of up to three tones, random noise, or various mixtures of the two with independent attack and decay envelopes.

Using the speed and processing power of a 16-bit microcomputer, such as

the TMS9940, it may well be possible to even teach the soon-to-be-available SN76489 complex sound generator to talk. The vocabulary of such a circuit would, of course, be quite limited, but perfectly adequate for a variety of annunciator circuits. It may prove feasible to expand some of the aircraft collision-avoidance systems to include an auditory response. Thus, rather than alarms or flashing lights which the pilot of an aircraft must interpret, a voice may well shout out, "Pull up. The aircraft is 100 feet below glidepath." Farther out in the future, voice recognition ability built into this flight-control system may well react to human vocal commands.

Microcomputer applications in the home have generally been limited to the kitchen, but this can be expected to change in the near future with more being accomplished in the areas of convenience and communications products.

Automatic telephone dialing, repertory dialing and automated phone-answering systems will become reasonably priced for the average homeowner through application of the microcomputer. It's likely that this will become popular in much the same way as the pushbutton phone has been replacing the circular dial. Uses of the phone can be expected to expand, allowing the homeowner to do his banking, pay bills, and send and receive printed information over the phone lines.

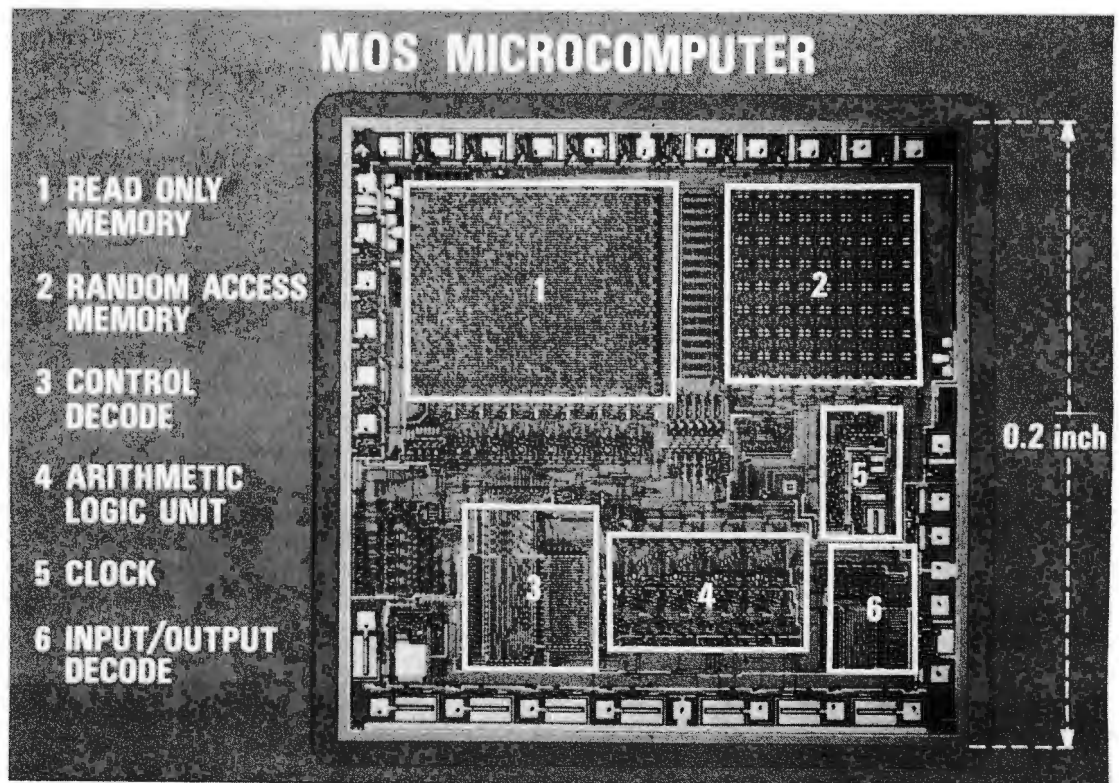


Photo of a microcomputer chip with important functional areas identified.

The key to this expanded use will be mass-acceptance of the personal or home computer.

In the 1960's, electronics hobbyists busied themselves with the design and construction of that "perfect" sound system. The spreading popularity of the hobby led to the commercialization and mass-production of those sophisticated systems to where they became readily available for a palatable cost.

In the 1970's, the hobbyist has also turned his attention to the computer. Developing games and other programs for the professional calculator once was a favorite diversion for computer specialists and mathematicians. As microcomputer modules became more readily available, the experimenter turned the calculator-based hobby into a microcomputer-based hobby. As happened with high-fidelity and stereo systems, electronics manufacturers have taken note of this spreading interest, developing first a series of personal computers specifically for the enthusiast and now products for even broader markets. Home computers are now available that require no computer-expertise or knowledge of programming. Software comes in pre-programmed ROM packages that simply plug into the computer much like the video game cassettes plug into the video games introduced in the mid-70's.

It's anticipated that the day will come in the future when a home computer will be another appliance designed to simplify and expand communications capabilities within the home. Through standard modern interfacing, it will connect to the telephone to provide the advantages of automated audio and visual communications. Electronic mail, electronic newspapers and automated communications will become commonplace. With an interface to the home electrical system, energy management and automated electrical control of any kind will be made possible.

The microcomputer will also make complex fire and security control systems practical realities for the consumer. Security systems will detect the presence of an intruder, and indicate the point of entry. This information will be displayed to both the homeowner and police via video monitors. Fire alarms will sense the location of a fire, calculate intensity and speed of growth, signal the occupants, indicate the safest route out of the house, and also alert the local fire department—again providing details of the fire via a video monitor.

Wouldn't it be convenient to have a

microcomputer-controlled lawnmower that, once it was run through the mowing sequence, would automatically follow that sequence time-and-time again? With the simple addition of radio-control, it might even be programmed to back itself out of the tool shed and start the mowing job.

The family car will not escape microcomputer control. In some of the luxury models, it is there now! A microcomputer will control brakes to equalize application of pressure to minimize skidding. The same microcomputer will control engine operation to minimize exhaust emissions and maximize economy. With recent advances in speech synthesis, the day will come when the family car will *tell* the driver when the fuel is low, oil pressure is approaching a danger point or it's time to buckle up.

The microcomputer has just begun to tap the immense potential that exists in the field of education. Learning aids such as TI's Little Professor™ and Speak & Spell™, with other products, have found wide acceptance as simple, low-cost handheld devices that help make learning fun. Calculators and computers are being adapted to classroom work to help teach not only the fundamentals of arithmetic but also the use of math as a pure, universal language.

Teacher and student response to calculator-oriented mathematic learning aids has been so enthusiastic that studies are now being conducted in ways to utilize the technology in other subjects. The time is not far off when students will be using calculator or computer-extended materials to learn reading, writing, spelling, geography, history and foreign languages. The science is still in its infancy, but is already perceived as a positive educational influence on many levels. Computer simulators, for example, of the kind most readily associated with driver education and flight training, will eventually be available in smaller, maybe even portable, units to provide specialized instruction in a number of diversified fields—from shop training to first aid, from bridge lessons to computer maintenance.

Among all of the new features, one to evolve will be the most important—ease of programming. Simplified programmability will lead to ease of use in applications undreamed of today. An exciting new area of development is synthetic speech and voice recognition. The technology to enable appliances to "talk" is not only here, but economically practical, as is evident in TI's "talking" learn-

ing aid, Speak & Spell. And some electronic experts predict that speech recognition will be cost-effective within another three to five years. By the mid-1980's, appliances may be intelligent enough to carry on simple conversations with consumers. One of man's fondest dreams—the interactive machine that listens, responds and talks back to him—is the next big challenge.

In the not-too-distant future, a homemaker may well put a frozen roast in a microwave oven before leaving for a day's shopping. After lunch she (or he) calls home and accesses the oven through the home computer, telling it to turn on at 4:00 p.m. The oven responds, "What temperature, please?" A few hours later, the homemaker arrives home and tells the door to open. The electronic lock recognizes the voice as authentic and opens the door. As the person enters the house, lights turn on as the room is entered and off as it is left—automatically! The oven will eventually announce over the home intercom, "The roast is ready."

Is this science fiction? Not at all! The technology to produce such a system is already at hand. Mass production for the consumer will have to wait a while, however. And behind it all is the evolution of the microcomputer revolution.

In the mid-Sixties, Margaret Meade described society as being in the midst of an information explosion, a situation where technology has provided the capability of gathering, organizing, storing and disseminating far more information much faster than ever believed possible; but man has yet to learn to synthesize this information. This is the problem facing the consumer electronics industry today. There is a wealth of information, products and capabilities available now through microelectronics. The "problem" is for creative manufacturers to synthesize this information into more efficient and useful appliances.

The nature of the consumer electronics industry is changing, as is the nature of the job functions within it. Individual product designers now work together as systems designers. Engineers who once rarely left their drawing boards are now active in consumer research. And manufacturers cannot afford to ignore human factors in product and control design or the potential of newly developed microelectronics. If they do, along with designers of the wringer washing machine, the horsedrawn buggy, and the ice box, they'll wonder what ever happened to the good old days. ◇



How to Add I/O Ports to Microcomputers

The basics of computer port operation and instructions for using them to expand computer flexibility

BY ADOLPH A. MANGIERI

FOR A microcomputer to "do something" truly useful, it must have input and output ports. The I/O ports make it possible for the computer to "interface" with practical devices—relays for appliance control, switches (or a keyboard) for feeding in desired commands, keyboard and video or hard-copy terminals for communicating with the computer, etc. Though 8080- and Z80-based micros can control up to 256 I/O ports, few are equipped with more than two. In this article, therefore, we will describe how to add I/O facilities to expand a Z80 or 8080 computer's flexibility.

To add the I/O ports described here to any Z80 or 8080 micro, you must have a basic familiarity with port operation and addressing and bus structure. (This information is detailed in manuals that accompany the computers.) A few ICs will get your computer up and running. Port examples presented here are for a

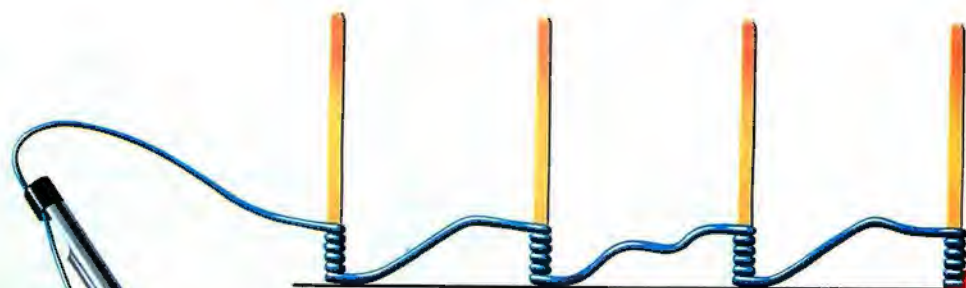
Radio Shack TRS-80 Level I computer that uses the T-BUG monitor and a Level II computer with machine code and BASIC. You can use a solderless breadboard to perform experiments and to prototype circuits.

Port Basics. There are a number of different types of I/O ports in use. An elementary port may simply display information on a bank of LEDs, operate relays, or input data from a bank of switches. A complex port, on the other hand, can accommodate such sophisticated devices as an ASCII keyboard, full-graphics CRT monitor, and hard-copy terminal. Although all ports share the common computer bus, each is assigned a specific address and is provided with logic circuitry that enables the port only when it is addressed.

Machine-code instructions define CPU input and output operations. Two-

byte instruction D3 XX initiates an output operation to a port. (D3 is the output instruction and the Xs indicate numbers for specific port addresses, such as D3 00, D3 01, D3 02, etc.) When a Z80 CPU fetches and executes this instruction, it generates an $\overline{\text{IOREQ}}$ (I/O request) pulse and a $\overline{\text{WR}}$ (write) pulse, both active low, as indicated by the lines above them. These are logically added in an external AND gate and delivered as the $\overline{\text{OUT}}$ pulse on pin 21 of the TRS-80's bus. The data byte in the CPU accumulator register is placed on data bus lines D0 through D7. Simultaneously, address byte XX is placed on address lines A0 through A7.

Port-select logic constantly examines the $\overline{\text{OUT}}$ and address lines, waiting for the simultaneous appearance of the $\overline{\text{OUT}}$ pulse and port address. When this occurs, the port is enabled and data on the data bus lines enters the port. Ad-



WHY CUT? WHY STRIP? WHY SLIT?
WHY NOT...

NEW

JUST WRAP™

WIRE
WRAPPING
TOOL

- AWG 30 Wire
- .025" Square Posts
- Daisy Chain or Point To Point
- No Stripping or Slitting Required
- ...JUST WRAP™...
- Built In Cut Off
- Easy Loading of Wire
- Available Wire Colors:
Blue, White, Red & Yellow

traditional Wire-Wrapping



JUST WRAP Wire-Wrapping



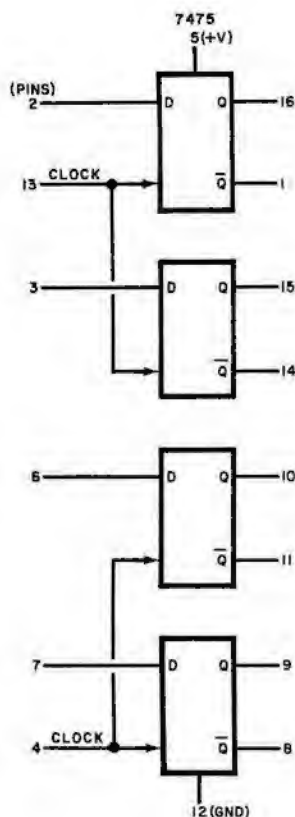
U.S.A., FOREIGN
PATENTS PENDING

JUST WRAP TOOL WITH ONE 50 FT. ROLL OF WIRE		
COLOR	PART NO.	U.S. LIST PRICE
BLUE	JW-1-B	\$ 14.95
WHITE	JW-1-W	14.95
YELLOW	JW-1-Y	14.95
RED	JW-1-R	14.95
REPLACEMENT ROLL OF WIRE 50 FT.		
BLUE	R-JW-B	\$ 2.98
WHITE	R-JW-W	2.98
YELLOW	R-JW-Y	2.98
RED	R-JW-R	2.98
JUST WRAP-UNWRAPPING TOOL		
	JUW-1	\$ 3.49



OK MACHINE & TOOL CORPORATION 3455 CONNER ST.,
BRONX, N.Y. 10475 (212) 994-6600/TELEX 125091

*MINIMUM BILLING \$ 25.00/ADD SHIPPING CHARGE \$ 2.00/NEW YORK CITY/STATE RESIDENTS ADD APPLICABLE TAX.



TRUTH TABLE

CLK	D	Q	EQUALS
0	X	0	LATCH
1	1	1	1

X = DON'T CARE STATE

Fig. 1. Internal logic of 7475 (including pin-out) and truth table for each latch.

dress bytes can be from 00 to FF (hexadecimal) to allow up to 256 output ports to be used with suitable decoding.

Machine-code instructions DB XX (input instruction with port address) initiates an input operation from the selected input port. Here, \overline{IOREQ} and RD (read) pulses are added in an external AND gate and delivered as the \overline{IN} pulse on pin 19 of the TRS-80's bus.

Port logic detects the simultaneous appearance of the \overline{IN} pulse and port address and enables the port. At this time, the port connects its output lines to the data bus and the CPU copies any data present on the bus into the accumulator register. After data acceptance, the port frees the data bus for other purposes. The accumulator register is the source and destination of data with the D3 and DB instructions. The Z80 instruction set includes a number of special I/O instructions that effect data transfers to and from other registers and memory, with some instructions allowing movement of data in blocks.

Output and input ports can have the same address, such as output D301 and

input DB 01. Port-select logic differentiates between the two by \overline{OUT} and \overline{IN} pulses. "Standard" or "isolated" I/O addressing allows up to 256 input and 256 output ports to be addressed by the computer. This is ample for just about any imaginable home computer system.

An alternative form of port addressing employs memory-mapped I/O. Each port, in effect, is addressed as memory. This method allows thousands of ports to be addressed and affords some programming advantages.

Simple Output Port. Inexpensive 7475 TTL ICs can be used to make 2-, 4-, and 8-bit latching-type output ports. As shown in the truth table in Fig. 1, data latch output Q follows input data D as long as the clock (CLK) line is high. When the CLK line goes low, data D is latched to output Q. The internal logic of the 7475, including pinout, is shown in Fig. 1. Note that each clock line drives two latches.

Two 7475's can be connected as an 8-bit latching port (Fig. 2). LEDs connected to the \overline{Q} outputs turn on when their respective data D input is high.

The port shown in Fig. 2 is addressed by instruction D3 00, which places binary 00000000 on lines A0 through A7. The least-significant bit is on A0. When \overline{OUT} and $\overline{A0}$ are true, the port is enabled by IC3A and the data byte held in the CPU accumulator register is displayed in binary on the LEDs. Address line bits

A1 through A7 are "don't cares," provided they are not assigned to other ports. Hence, instruction D3 FE also selects this port because bit A0 is low.

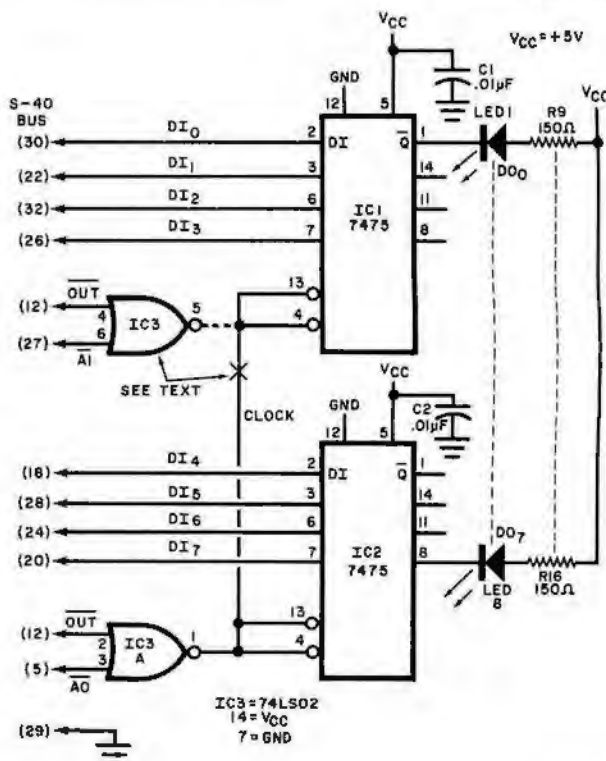
Ports that do not require all eight data bits are easily arranged. To set up two 4-bit ports, break the clock line at X and add the second NOR gate (Fig. 2). Port IC1 is enabled by instruction D3 01, which places binary 00000001 on the address lines. The 1 bit on line $\overline{A0}$ causes selection of port IC1. You can also separate the four clock lines and arrange four 2-bit ports, using address lines A2 and A3 for port selection.

Progressive addressing allows up to eight input and output ports to be used. One or more ports can be enabled by one instruction, simplifying programming and hardware requirements. Although it requires additional ICs in each port, full decoding of the address bits allows up to 256 input and output ports. For example, the TRS-80 cassette port is fully decoded and selected by instruction D3 FF. For this and other reasons, the ports described here are assigned active-low address bits for selection. For an elementary example of both fully decoded port and memory-mapped port, refer to the TRS-80 Technical Reference Handbook.

Complex I/O Port. Intel's versatile 8212 I/O chip can be used as either a latching or a nonlatching output port, input port, gated bus driver, or straight-

(Continued on page 56)

Fig. 2. Two 7475s and a 74LS02 can be used to form an 8-bit port or, with slight modifications, two 4-bit or four 2-bit ports.



● COMPUTER SYSTEMS ● SELF-INSTRUCTION PROGRAMS

INSTRUMENTS ● AMATEUR RADIO ● STEREO HI FI



FREE

HEATHKIT® CATALOG



HOME SECURITY ● TOOLS ● BOOKS

See the newest and finest electronic products for home, hobby and business—all in easy-to-build, money-saving kit form!

Something of
interest and
value for all!
Nearly 400 to
choose from.



☐ YES! Send me the Heathkit catalog.
I am not now receiving current catalogs.

Name _____

Address _____

City _____ State _____ Zip _____

PC-133

POPULAR ELECTRONICS

010-580

● AUTOMOTIVE ● MARINE ● AVIONICS ● CLOCKS ● WEATHER ● COLOR TV ●

**free
heathkit[®]
catalog**

**PLACE
STAMP
HERE**

The Post Office will
not deliver mail
without postage

HEATH COMPANY
Benton Harbor MI 49022

Congratulations To Popular Electronics

*We've enjoyed serving folks interested
in electronics for a long time, too!*

1926



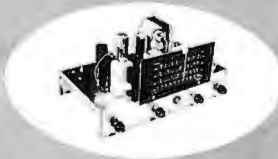
FIRST AIRCRAFT KITS An airplane was the Heath Company's first kit. Carrying the name, "the Heath Parasol," it sold for \$199 (less engine) in kit form.

1947



FIRST ELECTRONIC INSTRUMENT KITS The electronics era blossomed after World War II, and Heath was offering a kit-form oscilloscope for the low price of \$39.95 F.O.B. Benton Harbor.

1949



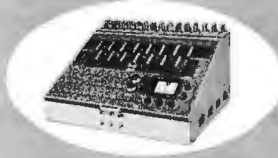
FIRST CONSUMER ELECTRONICS KITS Encouraged by the scope's success, Heath expanded its line and by '49 offered an FM tuner kit, a hi-fi amp, and a 3-tube "all-wave radio."

1952



FIRST AMATEUR RADIO KITS Amateur Radio gear entered the Heath line when a grid dip meter was offered in 1952, soon followed by the AT-1 CW transmitter kit.

1957



FIRST PERSONAL COMPUTER KITS In March of 1957, a new Heathkit flyer announced the introduction of two analog computer kits. The computer age had arrived for the kit builder.

1979



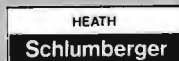
STILL THE WORLD LEADER IN QUALITY ELECTRONIC KITS When Popular Electronics began, who could have imagined the electronics in today's Heathkit Catalog? Write for your free copy now.

FREE

Send for it!

Heathkit

Heath Company,



Dept. 010-580
Benton Harbor, Michigan 49022

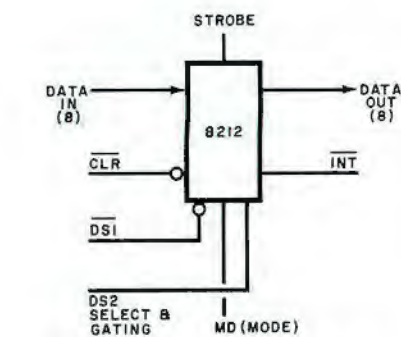


Fig. 3. The 8212, an 8-bit I/O port, and its truth table. This IC has tri-state provisions. That is, in one mode it can be electrically isolated from the system bus.

STATE	STB	MD	(DS1 · DS2)	D OUT EQUALS
1	0	0	0	3-STATE
2	1	0	0	3-STATE
3	0	1	0	LATCH
4	1	1	0	LATCH
5	0	0	1	LATCH
6	1	0	1	DATA IN
7	0	1	1	DATA IN
8	1	1	1	DATA IN

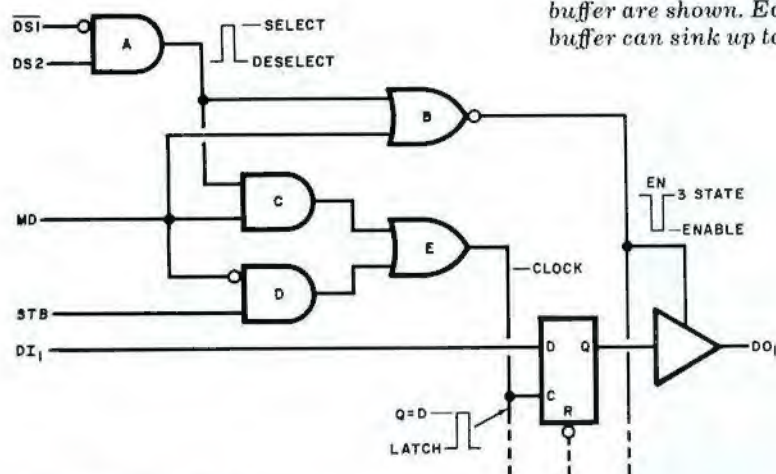


Fig. 4. A portion of the internal control logic of the 8212. Only one of its eight latches and output buffer are shown. Each output buffer can sink up to 15 mA.

(Continued from page 52)

through buffer, to name just a few of its applications. This high-speed Schottky TTL device includes eight data latches and output buffers that can be tri-stated (switched to high impedance). Each buffer can sink up to 15 mA.

The function diagram of the 8212 is shown in Fig. 3, which also illustrates chip signals and the IC's truth table. A portion of the internal control logic and one of the latches and its output buffer are illustrated in Fig. 4. For simplicity, CPU-interrupt control logic, which controls interrupt output INT, is omitted.

Familiarity with the control logic simplifies application. Mode control line MD is tied low (logic 0 or ground) for the input-port mode and high (logic 1 or V_{CC}) for the output-port mode. Lines $\overline{DS1}$ and $\overline{DS2}$ are the device-select, or gating-control, lines. When $\overline{DS1} \cdot \overline{DS2}$ is 1, the device is selected by a high at the output of gate A.

The data-latch clock is strobed two ways. When line MD is low, gate C is defeated and strobe line STB passes a pulse through gates D and E to the clock line. When line MD is high, gate D is de-

feated and gate A passes a pulse through gates C and E to the clock line. Similarly, the output buffers are also operated two ways. When line MD is high, gate B goes low and enables the buffers continuously. This is a necessary requirement for a latching-output port. When line MD is low, the selected pulse from gate A passes through gate B to enable the buffers briefly, after which they return to tri-state. This is a necessary requirement for an input port.

The truth table is simple to use if you keep in mind the port or application requirements. To illustrate, let us implement an input port. In this case, MD

FIRST REDUCED TRUTH TABLE

STATE	STB	$\overline{DS1} \cdot \overline{DS2}$	D OUT EQUALS
1	0	0	3-STATE
2	1	0	3-STATE
6	1	1	DATA IN

FINAL TRUTH TABLE

STATE	STB	$\overline{DS1} \cdot \overline{DS2}$	D OUT EQUALS
1	0	0	3-STATE
6	1	1	DATA IN

Fig. 5. Reduction of the truth table for the 8212.

must be tied low (grounded). Strike out all rows or states listing MD as 1 in the Fig. 3 truth table. Since MD is assigned, strike out column MD. We know from port basics that the input port must not latch onto the data bus. This eliminates state 5 and all that remain are states 1, 2, and 6, as shown in the reduced truth table in Fig. 5.

Clearly, state 6 must be retained for device selection and data transfer. Recalling that the STB line must be used to strobe the latches when line MD is 0, state 2 is deleted so that STB can alternate between 1 and 0. This results in the final truth table shown. Check this truth table to be sure it accomplishes the application's requirements. In this case, state 6 enables the port, placing port data on the data bus. State 1 "deselects" the port and tri-states the output buffers as required.

In the final step, computer pulses are assigned to $\overline{DS1}$, $\overline{DS2}$, and \overline{STB} . Available computer pulses are \overline{IN} and $\overline{A0}$, the latter assigned to this port and active low. Notice that STB and $\overline{DS2}$ are active high. With $\overline{DS1}$ active low, connect \overline{IN} to $\overline{DS1}$. Pass $\overline{A0}$ through inverter IC6A and then to both STB and $\overline{DS2}$ (Fig. 6).

To use the 8212 as a latching output port, tie MD high (to V_{CC}). Port requirements include device select with data in (state 7 or 8) and device deselect with latching (state 3 or 4). STB is a "don't care" line. Connect computer output pulse \overline{OUT} to line $\overline{DS1}$. Address line bit $\overline{A0}$ is inverted by IC7A and connected to line $\overline{DS2}$ (Fig. 6). The LED is off when D is high. If this is objectionable, add inverting buffers between port outputs and light-emitting diodes.

For the 8212 to serve as a straight-through buffer or line driver, requirements are device select, data out equals data in, and continuously enabled output buffers. State 8 will effect these requirements. Connect line MD and $\overline{DS2}$ to V_{CC} and line $\overline{DS1}$ to ground. For use as a bi-directional bus driver, interrupting ports, etc., see the Intel 8080 User's Manual.

Computer Hookup. The TRS-80 accepts a special 40-contact card edge connector. However, you can substitute a standard 44-contact card socket, such as a Vector No. R644-2, after modifying it. To do this, fit a thin piece of hard plastic into the connector slot to cover the two top and bottom contacts at one end of the connector. You now have a 44-contact connector that for all practical purposes has been modified to serve as a 40-contact connector.

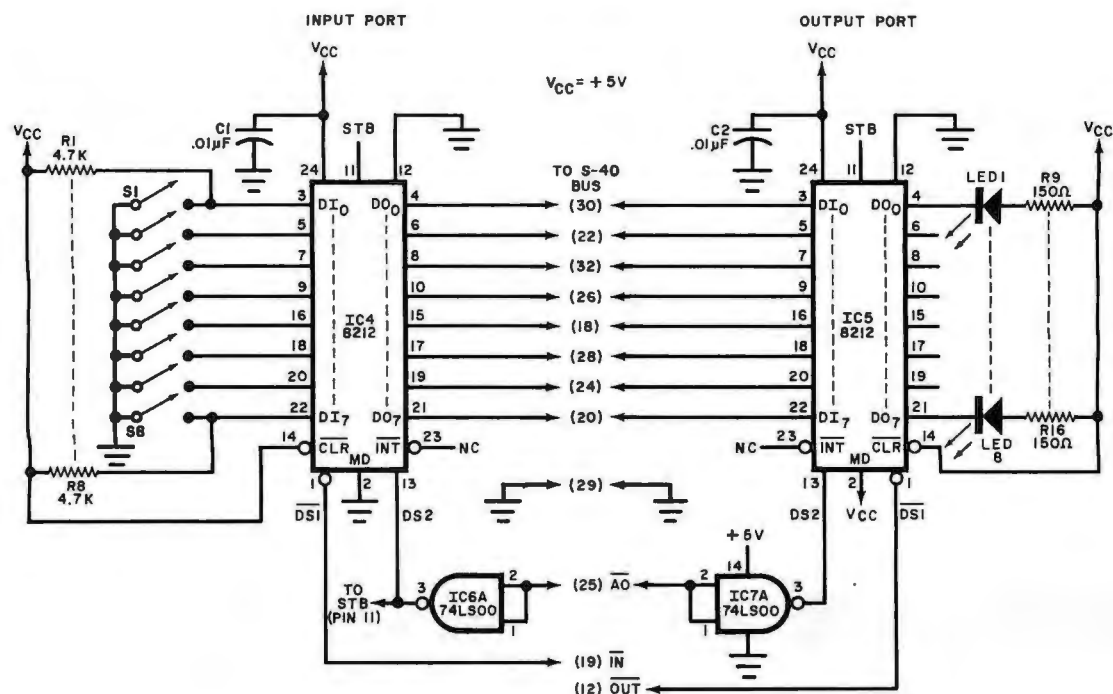


Fig. 6. An experimental I/O port using a pair of 8212s with switch inputs and light-emitting diode outputs.

PARTS LIST

C1,C2—0.01- μ F disc capacitor
 IC1,IC2—7475
 IC3—74LS02 NOR gate
 IC4,IC5—8212 8-bit I/O port
 IC6,IC7—74LS00 low-power quad 2-input NAND gate
 LED1 through LED8—Light emitting diode
 R1 through R8—4700-ohm resistor
 R9 through R16—150-ohm resistor
 S1 through S8—Spst switch

Install the modified connector in the TRS-80, making sure that lateral play barely exceeds 1/64" (0.4 mm). Carefully remove the modified connector and cement the small plastic pieces solidly in place. Recheck connector fit before the cement sets. Then use a lettering kit to mark an UP label on the up side of the connector.

Solder a 12" to 18" (30.5 to 45.7 cm) length of color-coded 40-conductor ribbon cable, such as Vector's No. KW2-40, to the connector. Make a record of which conductor connects to and what signals are present on each pin. Refer to the TRS-80 Technical Reference Manual or User's Manual for pin assignments.

At this point, you can choose any of a number of conventional construction approaches. Perhaps the simplest is to use a solderless breadboard on which to experiment with the I/O port. A 40-pin IDC connector, such as a Vector No. KS2-40, can be fitted to the end of the cable, using a Vector No. P187 IDC fixture to make the connection. A mating connector can then be mounted on the solderless breadboard. Shown in Fig. 7 is this author's experimental setup, which includes wiring to a home-built card cage (Fig. 8) to support Wire Wrap circuit cards.

In Conclusion. From the foregoing, you can see that it is relatively simple to interface a computer with external devices to perform useful operations. You could conceivably use all 256 I/O ports to control everything in your home. ◇

Fig. 7. Three computer links are provided on this patchboard using solderless circuit connections. Wire-Wrapping is used on connectors and under chassis.

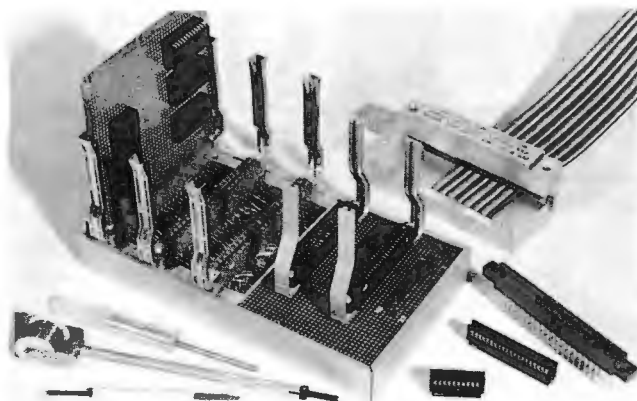
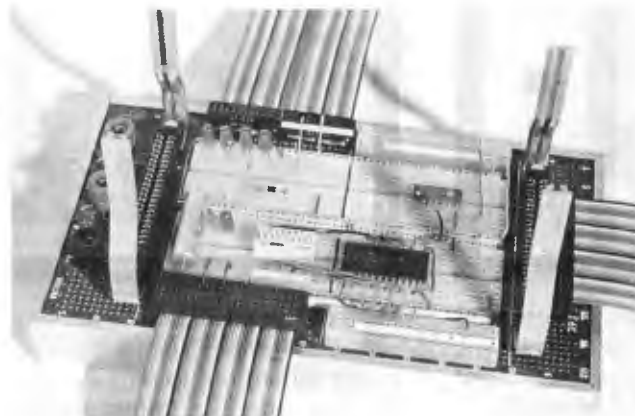


Fig. 8. Typical plug-in card chassis. Three large sockets are Vector Electronics R644-3 with mating BR27-D card guides. Smaller connectors are R644-2 with BR27 card guides. Wire-forming and chiseling tools are also shown.

TV-RECEIVER problems can cause the strangest video effects. Pictured here are ten mostly uncommon symptoms, each accompanied by a description of the usual cause.

Before troubleshooting TV circuitry, one

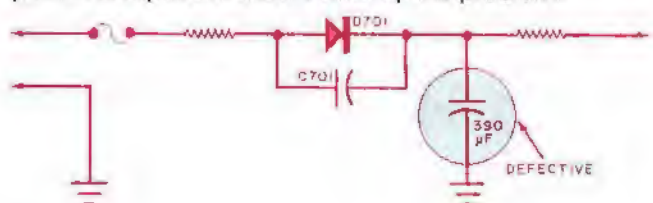
should bear in mind that servicing a TV chassis can be dangerous. Therefore, always remember to disconnect the ac line cord from the wall outlet and discharge all electrolytic capacitors in the chassis before attempting any work.

TEN UNCOMMON TV-RECEIVER PROBLEMS

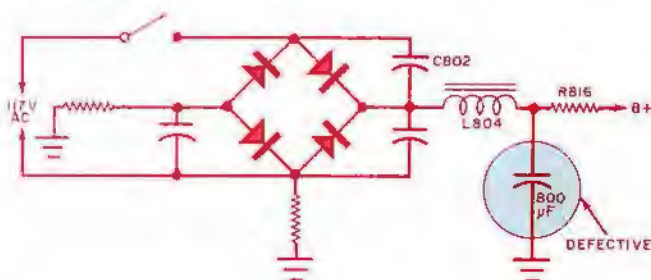
BY HOMER L. DAVIDSON



HERE WE have a typical filter-capacitor problem, with hum bars running through the picture plus insufficient width. The picture cannot be straightened out by operating the horizontal-hold control. The source of the problem can be found by examining the terminal connections of the suspected filter capacitors. Look for a white or black substance that has oozed out around the terminals or a bulge in the case of the capacitor. The first filter or voltage-doubling capacitors are the likely culprits. Reduced voltage and excessive "hash" on an oscilloscope waveform indicate a defective filter capacitor. Shunting a good capacitor across the suspected component should clear up the problem.



THIS "foggy" picture appeared on the screen of a J.C. Penney Model 2874 portable TV receiver. Its cause turned out to be a defective 800- μ F, 180-volt filter capacitor. The partial schematic diagram gives the capacitor's location in the circuit.



THE GREATEST EVENT IN HI-FI.

A great high fidelity system is very easy on the ears, but not always very easy on the budget.

But now, for this month only, you can buy Pioneer high fidelity components for savings unlikely to be repeated.

For the first time in history you can take advantage of the great Pioneer Month Sale.

Pioneer has reduced many prices to our dealers for this sale to make it possible for them to pass these savings on to you.

Every receiver has been specially priced. Including the industry's best selling SX-780, which critics say, "has a level of performance that's hard to distinguish from that of much more expensive receivers."

Every quartz turntable. Including Pioneer's high-end PL-630.

Even our PL-518,

already considered by many to be the best engineered direct drive turntable for the money, has been specially priced.

The great Pioneer Month Sale also covers tape decks. Including the hottest selling deck of the year, the CTF-900, featuring Fluorescan metering. Our latest series of amps and tuners. Speakers. Headphones. Even add-ons. Like our TV tuner that brings big screen sound to the little screen.

Most people think they have to wait till January to afford the component they wanted to give in December. But not anymore.

So if the component you set your heart on costs an arm and a leg, come to your local Pioneer dealer during Pioneer Month Sale. You'll find the item that was once out of reach is now within your grasp.

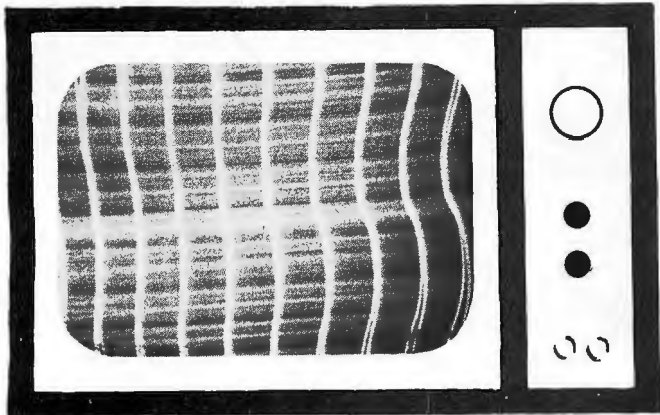
Pioneer Month Sale is only at your participating Pioneer dealer.

Look for the Pioneer Month Sale wall poster or banner in your dealer's window. It will direct you to Pioneer Month Sale, that's really the sale of the year.

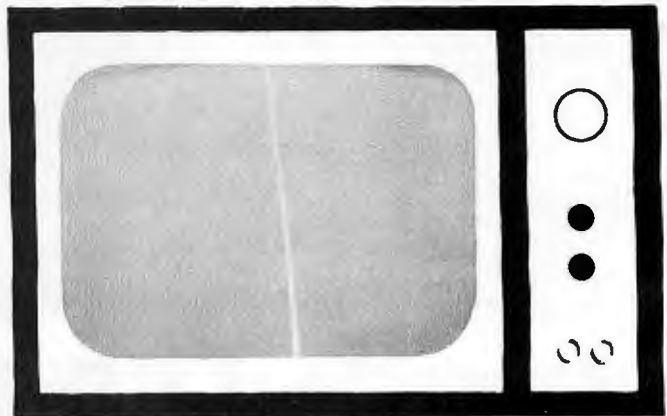
PIONEER MONTH SALE!

©1979 U.S. Pioneer Electronics Corp., 415 Oxford Drive, Moonachie, N.J. 07074
Manufacturer's suggested retail prices. Actual prices will be set by individual dealers.
CIRCLE NO. 56 ON FREE INFORMATION CARD





WHEN THE picture pulls and squirms as shown here, try adjusting the horizontal and vertical controls. If this does not help, try shunting the filter capacitors, one at a time, with a new capacitor with a rating of at least 100 μ F and no less than the voltage at which the suspected capacitor is rated. (Do not forget the precaution noted earlier when doing this.) When the humbar condition disappears, you have located the faulty capacitor and can replace it with a new component. If the defective capacitor is in one can with other capacitor elements, replace the whole unit because the other elements are likely to become defective soon.



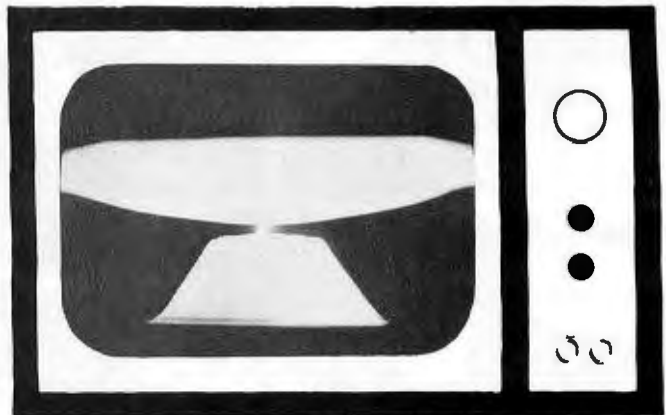
THE PICTURE illustrates what happened when a winding was open in the horizontal section of a deflection yoke. Since the line goes from top to bottom in the center of the screen, we know that high voltage and vertical height, both essential ingredients in obtaining a TV picture, are present. What is missing is horizontal sweep to spread the picture across the screen.

You can check continuity of a deflection yoke with an ohmmeter while it's on the neck of the picture tube. (Power must be "off," of course.) Most horizontal windings have a resistance between 10 and 50 ohms. Check the red, white, or orange wire going to the yoke. (Always disconnect the red wire to obtain correct continuity.) The vertical yoke wires are color-coded yellow, green, or black.



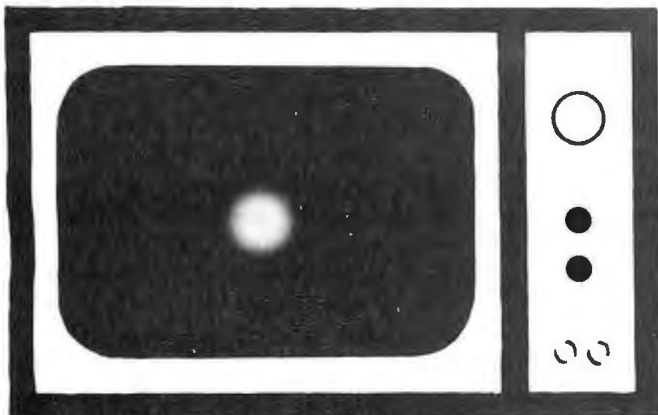
SOMETIMES when the brightness control is turned fully up, a picture may "bloom" or go out of focus. When the picture is out of focus all the time, no matter where the brightness control is set, suspect a defective picture tube, focus rectifier, or other component in the focus circuit. The first thing to do here is to locate the focus control on the rear apron and adjust for best focus. If that does not help, check for a defective component.

Look for a focus-rectifier tube near or on one side of the high-voltage cage. Typical tube numbers are 1V2 and 2AV2. If you cannot locate a rectifier tube, even after referring to the tube list on the side of the cabinet or high-voltage cage, the chassis uses a solid-state rectifier, which will be located inside or under the chassis. If you have access to a high-voltage probe, focus voltage should read 4.3 to 5.5 kV. A defective picture tube must be checked with a CRT tester.

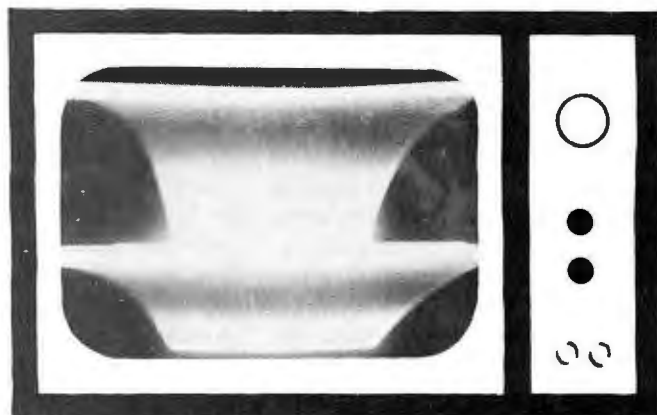


LARGE filter capacitors in a TV receiver chassis are particularly prone to breakdown. Most such problems result from drying out of the capacitors after being in service for years. Although the problem shown in this photo is capacitor related, it was not caused by drying out. It is the result of a broken trace on the printed circuit board at the base of the main filter capacitor in a Midland Model 15-023 monochrome TV receiver.

The problem was located when the capacitor was accidentally moved and the picture was restored to normal. Careful inspection revealed that the capacitor's ground lugs were torn loose from the pc board. Heavy, bare hookup wire and solder secured the capacitor into position. The partial schematic diagram shows where the filter capacitor is located in the circuit.



HERE IS a problem that usually crops up *after* you have performed some repairs on the chassis of a TV receiver. If you inspect the chassis, most likely you will find that you have forgotten to plug in the yoke assembly. This cannot occur on every TV chassis, because some have a low-voltage tie-in jack to prevent it from happening.

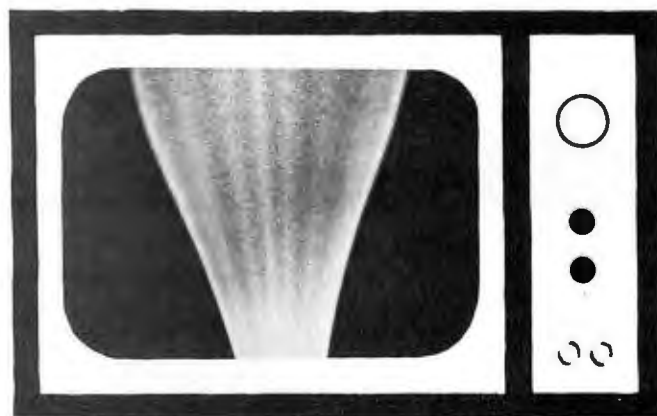


HERE WE see a video problem that occurred in a Panasonic ETA-3 portable color-TV receiver chassis. It resembles, perhaps, a double-tiered water fountain. Moreover, there was even a gurgling sound coming from the speaker. The source of the problem turned out to be filter capacitor C853, rated at 1200 μ F and 160 volts. This tall capacitor is at the right rear of the chassis, behind the high-voltage cage.

This type of problem can be verified by shunting the suspected capacitor with a component of similar ratings. To prevent arcing and damage to transistors in the receiver, turn off the power, clip the new capacitor across the old, and turn on the power. If the filter capacitor was indeed the culprit, the picture should return to its normal condition.



PERHAPS you have seen this picture problem before, with very thin lines running across the screen. Here we find a whole section of the picture masked by noise. This is not a receiver problem. It was the result of interference from a microwave oven, but could also have been caused by any other electrical appliance or even a fluorescent-lighting fixture. Sometimes an ungrounded furnace motor will produce such picture interference. By grounding the appliance or motor and plugging it into a noise-eliminator socket, you can do away with or drastically reduce the interference.



WHENEVER you see a picture with the sides at an angle, as shown here, suspect a shorted deflection yoke. If it is the yoke, you might even see a curl of smoke coming from it, indicating arcing between windings, when power is turned on. When no telltale smoke is present, you may be able to pinpoint a shorted-yoke problem by turning on the receiver and operating it for about a half hour. Then turn off power, discharge the capacitors, and remove the picture-tube socket and yoke assembly. Feel the inside of the yoke assembly for warm or hot spots. If you locate a hot spot, you have located the point at which the yoke is shorted. Replacement of the deflection yoke is the only cure.

AS POWER amplifiers grow in output capability and audiophiles insist on realistic listening levels, the likelihood that loudspeakers will be overdriven and damaged increases, too. It is possible that a single large pulse of energy could send the speaker voice coil and whatever happened to remain attached to it on a ballistic trajectory across the room, but this is a rare failure mode. Loudspeakers are usually damaged thermally; too much power is dissipated in the voice coil for too long a time, raising the temperature to the point where a breakdown occurs. (See "The Importance of Power-Handling Capacity," POPULAR ELECTRONICS, March 1979.)

"Power" meters, often added to amplifiers to monitor output, can show when the amplifier is being overdriven, but they do not tell much about the thermal stress applied to the loudspeaker. This is because they measure the voltage applied to the loudspeaker and calculate the power on the assumption that

the loudspeaker is a nonvarying pure resistance across the audio band, using the relation $P = E^2/R$, where P is power, E voltage, and R resistance. Meanwhile, the actual power delivered to the speaker (which causes the heating) varies with the magnitude of its impedance and the phase angle between current and voltage, both of which are functions of frequency.

The True Audio Power Meter project presented here gives an indication of the actual power delivered to the loudspeaker voice coil. (Since typical loudspeaker efficiency is of the order of 1% or less, it is reasonable to neglect the acoustic output power and assume that all the power is dissipated as heat.) This information is displayed on a peak-reading LED string and on an analog meter that can be switched between peak- and average-reading modes. The power reading is accurate to within a few percent, and is independent of variations in the loudspeaker impedance.

Operating Principles. The meter senses voltage and current and processes them into a signal whose amplitude is proportional to power. A block diagram of the meter is shown in Fig. 1. The heart of the project is a four-quadrant analog multiplier. This IC accepts input signals from voltage- and current-sensing networks and continuously generates their product. The resulting output signal is proportional to the instantaneous power delivered to the speaker. Variations in speaker impedance and phase angle are taken into account.

The rest of the circuit processes this constantly changing product signal to provide a readout of either average power or peak power. When the mode selector switch is in the AVERAGE position, the output voltage developed by the multiplier is fed directly to a meter-driving circuit that converts the voltage into current fluctuations. The inertia of the meter movement results in a readout of average power.

(continued on page 64)

Instrument indicates an audio amplifier's true output power

BY JOHN R. HUNT

Audio Power Meter



From PERCOM

One-Drive System:

\$399. (40-track) & \$675. (77-track)

Two-Drive System:

\$795. (40-track drives) & \$1350. (77-track drives)

Three-Drive System:

\$1195. (40-track drives) & \$2025. (77-track drives)

Requires Expansion Interface, Level II BASIC & 16K RAM.



Low Cost Add-On Storage for Your TRS-80*. In the Size You Want.

When you're ready for add-on disk storage, we're ready for you.
Ready with six mini-disk storage systems — 102K bytes to 591K bytes of
additional on-line storage for your TRS-80*.

- Choose either 40-track TFD-100™ drives or 77-track TFD-200™ drives.
- One-, two- and three-drive systems immediately available.
- Systems include Percom PATCH PAK #1™, on disk, at no extra charge. PATCH PAK #1™ de-glitches and upgrades TRSDOS* for 40- and 77-track operation.
- TFD-100™ drives accommodate "floppy disks." Store 205K bytes per mini-disk.
- Low prices. A single-drive TFD-100™ costs just \$399. Price includes PATCH PAK #1™ disk.
- Enclosures are finished in system-compatible "Tandy-silver" enamel.

Whether you need a single, 40-track TFD-100™ add-on or a three-drive add-on with 77-track TFD-200™s, you get more data storage for less money from Percom.

Our TFD-100™ drive, for example, lets you store 102.4K bytes of data on one side of a disk — compared to 80K bytes on a TRS-80* mini-disk drive — and 102.4K bytes on the other side, too. Something you can't do with a TRS-80* drive. That's almost 205K bytes per mini-disk.

And the TFD-200™ drives provide 197K bytes of on-line storage per drive

— 197K, 394K and 591K bytes for one-, two and three-drive systems.

PATCH PAK #1™, our upgrade program for your TRSDOS*, not only extends TRSDOS* to accommodate 40- and 77-track drives, it enhances TRSDOS* in other ways as well. PATCH PAK #1™ is supplied with each drive system at no additional charge.

The reason you get more for less from Percom is simple. Peripherals are not a sideline at Percom. Selling disk systems and other peripherals is our main business — the reason you get more engineering, more reliability and more back up support for less money.

In the Product Development Queue . . . a printer interface for using your TRS-80* with any serial printer, and . . . the Electric Crayon™ to map your computer memory onto your color TV screen — for games, animated shows, business displays, graphs, etc. Coming PDD!

™ TFD-100, TFD-200, PATCH PAK and Electric Crayon are trademarks of PERCOM DATA COMPANY.

*TRS-80 and TRSDOS are trademarks of Tandy Corporation and Radio Shack which have no relationship to PERCOM DATA COMPANY.

PERCOM

PERCOM DATA COMPANY, INC.
211 N. KIRBY • GARLAND, TX. • 75042

To order add-on mini-disk storage for your TRS-80*, or request additional literature, call Percom's toll-free number: 1-800-527-1592. For detailed Technical information call (214) 272-3421.

Orders may be paid by check or money order, or charged to Visa or Master Charge credit accounts. Texas residents must add 5% sales tax.

Percom 'peripherals for personal computing'

The output of the multiplier is also fed to the input of a peak-detecting circuit that captures and briefly holds short-lived transients. With the mode switch set to **PEAK**, the output of the peak detector is routed to the meter-driving circuit to display peak power. The output of the peak detector is fed at all times to four comparators that drive indicator LEDs. The thresholds of the comparators are set to divide the range into successive 25% increments. Therefore, with the range select switch set for 20 W full-scale, the four peak-indicator LEDs turn on at 5, 10, 15 and 20 watts. The range selector controls sensitivity of both the meter and the peak display for either range. An analog meter is used because of its ability to convey signal trends to the observer quickly.

Circuit Details. A schematic diagram of the True Audio Power Meter is shown in Fig. 2. The relative complexity and cost of the circuits make it practical to monitor only one audio channel at a time. However, to maintain proper isolation of the audio power output lines from switching transients and from each other, separate current-sensing resistors are used for each stereo channel. Additional sense resistors and appropriate modifications to switch S2 can be used to adapt the circuit for four-channel monitoring. Current sensor resistors *R1* and *R2* are in series with the speakers of their respective channels. The channel selector *S2* routes the voltages from either channel to the signal-processing circuits, where they are adjusted in level to be in the optimum range of the four-quadrant multiplier. The voltage appearing across the speaker is applied to divider network *R3/R4* and the attenuated

PARTS LIST

BTS1, BTS2—Four-conductor barrier terminal strip
 C1, C2—470- μ F, 35-volt electrolytic
 C3, C4—10- μ F, 25-volt electrolytic
 C5, C6, C7—0.1- μ F disc ceramic
 D1, D2, D3, D4—1N4002 rectifier
 D5, D6, D7—1N914 signal diode
 F1— $\frac{1}{4}$ -ampere fast-blow fuse
 IC1—RC4195 bipolar voltage regulator (Raytheon)
 IC2—TL074CN BIFET quad operational amplifier (Texas Instruments)
 IC3—AD533JH or AD530J four-quadrant multiplier (Analog Devices; see text and note below)
 IC4—LM339N quad comparator (National Semiconductor)
 LED1 through LED5—TIL220 or equivalent light-emitting diode
 M1—0-to-1-mA meter movement (Radio Shack 22-052 or equivalent)
 Q1, Q2, Q3, Q4—2N3904 npn switching transistor
 The following are $\frac{1}{4}$ -watt, 5% resistors unless otherwise specified.
 R1, R2—0.1-ohm, 15-watt wirewound power resistor (Dale HLM-15 0.1 or equivalent)
 R3, R12—22,000 ohms
 R4—3900 ohms
 R5, R7—1000 ohms
 R6—12,000 ohms
 R8, R9, R10—20,000-ohm, pc-mount trimmer potentiometer
 R11, R15—10,000 ohms
 R13, R33, R34—10,000-ohm, pc-mount trimmer potentiometer
 R14—500,000-ohm, pc-mount trimmer potentiometer

R16, R26, R27—2200 ohms
 R17—10 megohms
 R18, R19, R20, R21—1000-ohm, 1% tolerance, metal-film precision resistor
 R22, R23, R24, R25—15,000 ohms
 R28, R29, R30, R31—1500 ohms
 R32—5600 ohms
 S1—Spst switch with 1-ampere (115 volts ac) contacts
 S2—3pdt switch
 S3—Spst switch
 S4—Dpdt switch
 T1—36-volt, 170-mA, center-tapped transformer (Signal Transformer No. 241-4-36 or equivalent; see note below)
 Misc.—Printed circuit board, suitable enclosure, fuseholder, line cord and strain relief, 10-ohm, 100-watt resistor for calibration purposes (see text), hookup wire, solder, hardware, etc.
 Note 1—Four-quadrant multiplier IC3 is manufactured by Analog Devices Inc., Route 1, Industrial Park, Box 280, Norwood, MA 02062 (617-329-4700).
 Note 2—Power transformer T1 is manufactured by Signal Transformer Co., 500 Bayview Ave., Inwood, NY 11696.
 Note 3—The following are available from Select Circuits, 1411 Lonsdale Rd., Columbus OH 43227: drilled and plated fiberglass pc board (#AWM-1) at \$7.95; IC3 Analog Devices AD533JH at \$9.95; mini-kit (#AWM-MK) consisting of the above plus IC1, IC2, IC4, LED1-LED5, R1, R2, R18 through R21, T1, and a 10-ohm, 100-watt noninductive resistor at \$44.95. Prices include shipping in U.S., Canada and Mexico. Others add 20% for Air Mail.

signal is applied to the pin-1 Y input of multiplier IC3.

The low-level voltage across *R1* or *R2* is proportional to the current flowing through the speaker. Inverting amplifier IC2A raises the signal to a usable level and inverts it to bring it into phase with the voltage applied to the multiplier's Y

input. The output of amplifier IC2A goes to the pin-6 X input. Potentiometers *R8*, *R9*, and *R10* permit multiplier IC3 to be trimmed for optimum accuracy.

The output of the multiplier (instantaneous product of the X and Y input signals) is applied to mode switch S3 and

(continued on page 68)

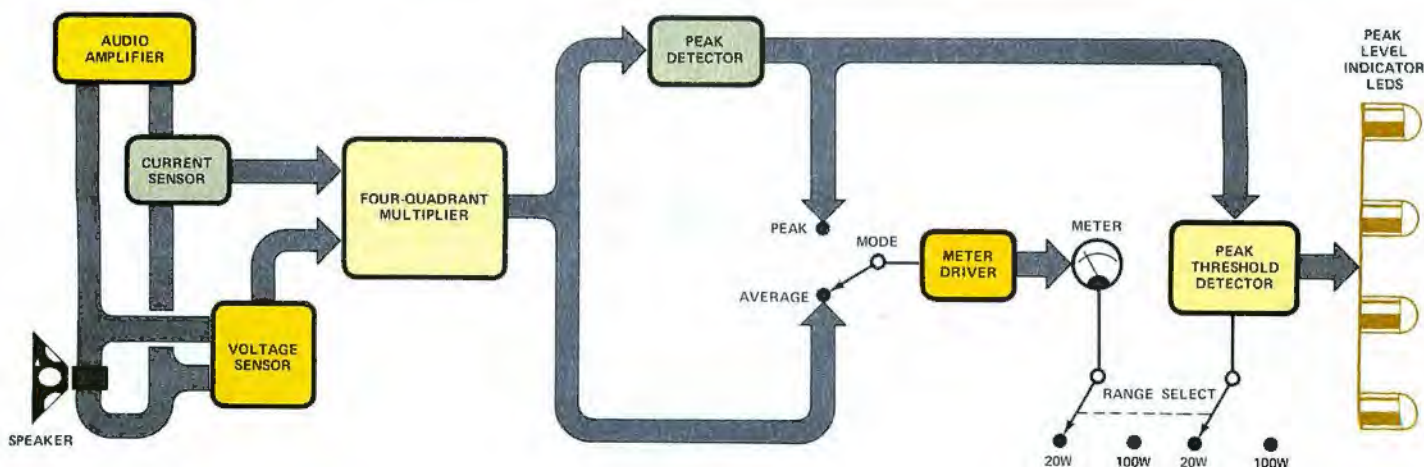
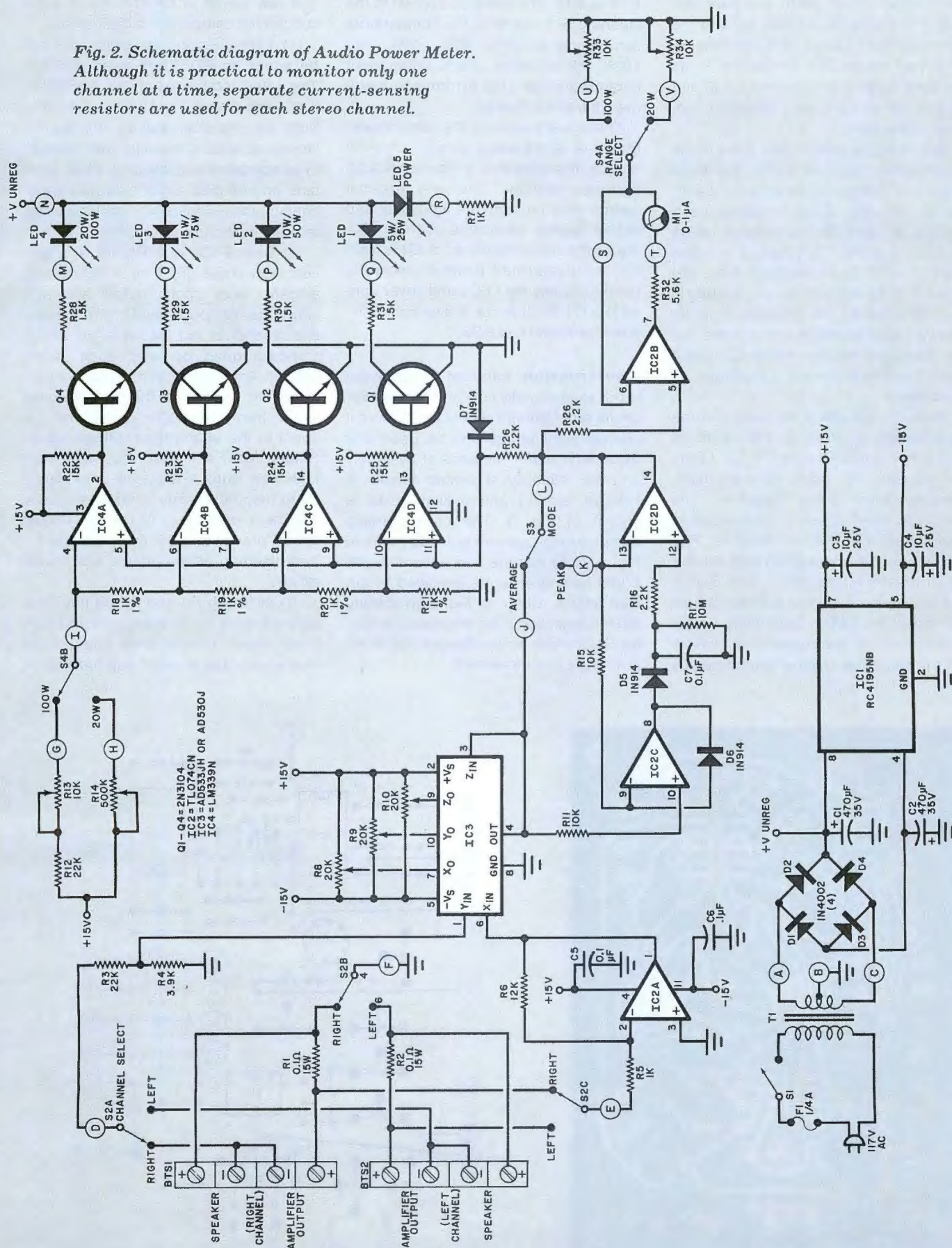


Fig. 1. Block diagram shows how four-quadrant analog multiplier is at heart of Power Meter.

Fig. 2. Schematic diagram of Audio Power Meter. Although it is practical to monitor only one channel at a time, separate current-sensing resistors are used for each stereo channel.



IC2C. When S3 is set to AVERAGE, the output of the multiplier also goes to the noninverting (+) input of IC2B. This op amp has meter M1 connected in its feedback loop. Potentiometers R33 and R34 serve as full-scale calibration controls for the meter.

The multiplier output also goes to the noninverting input of IC2C, the input stage of a buffered peak detector. Operational amplifier IC2D functions as a voltage follower for the positive peaks held by capacitor C7. Its output is routed back to IC2C by its feedback loop. Resistor R15 allows IC2C to be clamped in its "off" state by D6, resulting in faster recover. Brief transient peaks in the music waveform rapidly charge C7 which holds them long enough to be shown on the meter.

Resistor R26 feeds the output of the peak-detecting circuit to the inputs of comparators IC4A through IC4D. Diode D7 prevents the inputs of these comparators from going negative. The threshold level of each comparator is determined by divider resistors R18 through R21 in conjunction with calibration resistors R12 through R14. Switch S4 selects the full-scale reading of both the meter and LEDs. Depending on the position of S4, the upper end of R18-R21 is set at the voltage determined by

R13 or R14. The voltages applied to the inverting (-) inputs of the comparators correspond to 25%, 50%, 75%, and 100% of full-scale. Each comparator controls a single LED to form a four-element bargraph display.

The power supply for the Audio Power Meter is a relatively simple ± 15 -volt source. It is based on a Raytheon dual-tracking regulator. The only external components required are input filter and output bypass capacitors (C1-C4). Because the current capacity of IC1 is limited, an unregulated positive voltage is used to supply the LEDs and driver transistors Q1 through Q4. A pilot-light function is provided by LED5.

Construction. Although circuit layout is not exceptionally critical, conventional circuit arrangement should be followed if point-to-point wiring is to be used. For those who prefer the ease of assembly and the reliability of printed circuits, a full-size etching and drilling guide is shown in Fig. 3. The corresponding component-placement guide appears in Fig. 4. Note that the connections to off-board components are identified by circled letters. Refer to Fig. 2 to identify each connection. Use of sockets or Molex Soldercons for the integrated circuits is strongly recommended.

A few words of caution are in order concerning component substitutions:

(1) Four-quadrant multiplier IC3 can be either an AD533JH or an AD530J. The rated total error of the AD530J is $\pm 1\%$ and that of the AD533JH is $\pm 2\%$. Both are manufactured by Analog Devices and were chosen for their simplicity of operation and low cost. They combine on one chip a four-quadrant transconductance multiplier, stable voltage reference, and output amplifier.

(2) Device IC2 is a TL074CN, a low-cost, low-noise JFET-input operational amplifier with bipolar output and high slew rate. Although pin-for-pin compatible, it should *not* be replaced with a standard quad op amp such as an LM324. Amplifier IC2A must have a high slew rate to prevent the current-sense signal from lagging in phase with respect to the unamplified voltage signal. Stages IC2C and IC2D must also have high slew rates to allow the peak detector to respond quickly to brief transients. The high impedance of the JFET input circuit prevents IC2D from loading C7 and bleeding off the charge accumulated in it.

(3) Although R1 and R2 do not dissipate as much as 15 watts, resistors with lower power ratings were found to be inadequate because of self-heating. At

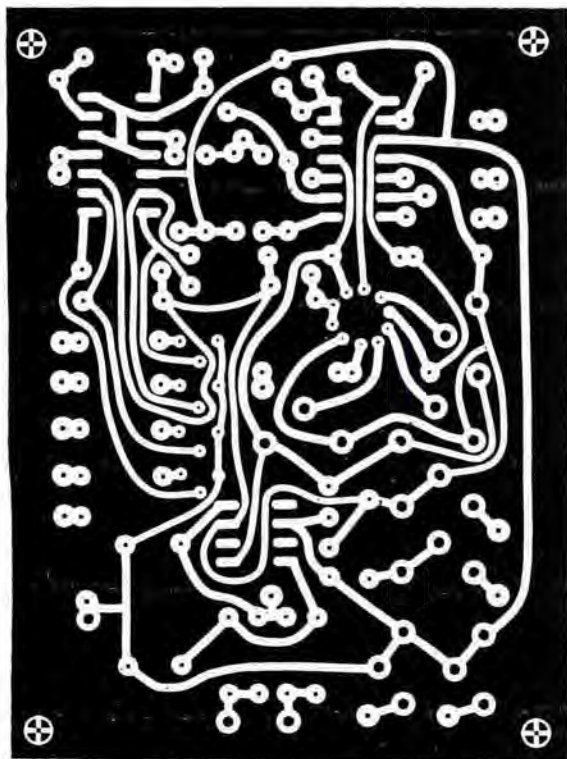


Fig. 3. Full-size etching and drilling guide for printed circuit board.

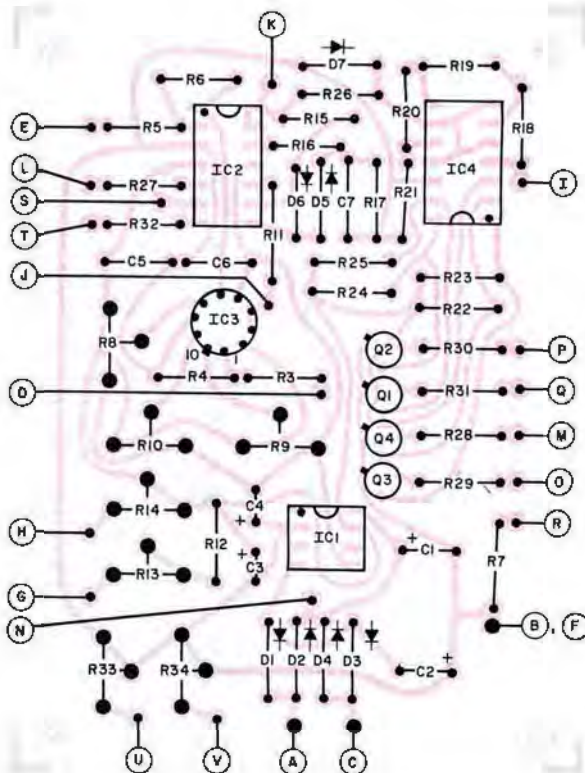
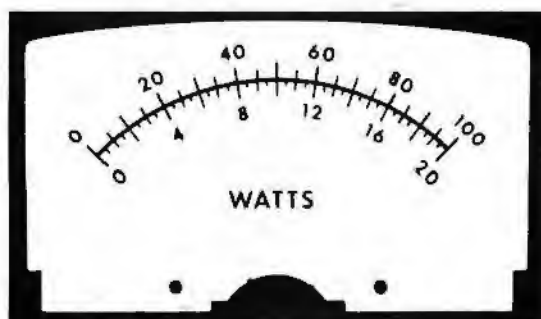


Fig. 4. Component layout guide for pc board. Circled letters connect to off-board components.

Fig. 5. You can make your own meter scale or cut this one out and glue it to the suggested meter.



medium power levels, 5-watt current-sense resistors changed value by several percent.

(4) Several other resistors, $R18$ through $R21$, affect the accuracy of the discrete LED power-level indicators. The threshold at which full-scale level indicator LED4 starts to glow is determined by the settings of $R13$ and $R14$. The accuracy of the lower-level thresholds, however, is set by the tolerances of $R18$ through $R21$.

Assembly. To prevent damage to expensive parts (especially the multiplier), verify operation of the power supply prior to installing $IC2$, $IC3$ and $IC4$. For testing, the load presented by the completed project can be simulated by separate 680-ohm, $\frac{1}{2}$ -watt resistors connected across $C3$ and $C4$. The potential across $C3$ should measure +14.5 to +15.5 volts, while that across $C4$ should be -14.5 to -15.5 volts.

You can make your own scale for meter $M1$ or cut out and glue the one shown in Fig. 5 to the face of a Radio Shack No. 22-052 0-to-1-mA dc meter. To do this, carefully remove the protective plastic cover and the two screws that secure the metal plate on which the scale is printed. Take care to avoid bending the meter pointer when you slide out the scale plate. Spray the scale plate with a coat of black paint. This will prevent the original scale lettering and any printing on the other side of the cut-out scale from showing through when the new scale is glued in place. Allow the glue to dry and then reinstall the scale plate on the face of the meter and snap the plastic cover in place, taking care to align the lug attached to the zero-adjust screw on the cover with the corresponding slot in the meter movement. Finally, set the zero-adjust screw so that the pointer is centered over the zero line on the left end of the scale.

Calibration. The first step in calibration is to trim the settings of the potentiometers for multiplier $IC3$. This can be

done using a signal generator capable of delivering a 20-volt peak-to-peak sine wave at a frequency of 50 Hz or, if such a generator is not available, a common 6.3-volt ac filament transformer. To use the transformer, connect the 6.3-V secondary across a 500-ohm potentiometer and tap the signal at the wiper (Fig 6).

Proceed by placing channel select switch $S2$ in its RIGHT position, which grounds the RIGHT SPEAKER + terminal. Next, ground both voltage sense and current sense inputs by shorting the RIGHT AMPLIFIER + and - terminals to the RIGHT SPEAKER + terminal. Then set $S3$ to AVERAGE and $S4$ to 20 w. Close $S1$ and the meter's pointer should momentarily deflect up-scale and any or all of the level indicator LEDs might glow briefly and then darken in descending order. Adjust $R10$, for a precise zero indication on the meter. (This is a dc null adjustment that can drive the meter above or below zero.) Open $S1$, and the pointer will again deflect up-scale and the LEDs may glow briefly.

The next adjustments will minimize ac feedthrough at the X and Y inputs. If one input is held at zero (ground), the output level should remain at ground regardless of the signal applied to the other input, but practical multipliers contain sources of error and can only approximate zero feedthrough. Do not disturb the connections made to ground for the dc null adjustment. If you are using a signal generator, set its controls so that it produces a 50-Hz sine wave with an amplitude of 17 volts peak-to-peak or 6.0 volts rms. If you are using a filament transformer, you will be supplying a 60-Hz signal taken from the wiper of the 500-ohm potentiometer, as was done

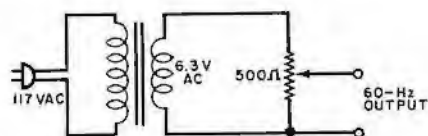


Fig. 6. Using filament transformer and potentiometer as signal source.

previously. Adjust the potentiometer so that a 6.0-V rms (17-V peak-to-peak) output signal appears at the wiper. Set the switches as follows: power $S1$ to ON; channel select $S2$ to RIGHT; range select $S4$ to 20 w; and mode select $S3$ to PEAK. Apply the 6.0-V rms signal to the junction of resistors $R3$ and $R4$ and remove power from the project.

Next, disconnect the inverting input of $IC2A$ from $R1$. Otherwise, any test signal would be shorted to ground by the low resistance of $R1$. This is most easily accomplished by disconnecting the wire running from the side of $R1$ that is connected to the positive AMPLIFIER OUTPUT terminal to $S2C$. Unsolder the wire at $R1$, leaving it connected to $S2C$.

If you are using a signal generator, adjust it so that it produces a 50-Hz sine wave with an amplitude of 0.5 V rms (1.4 V peak-to-peak). If you are using a filament transformer, adjust the potentiometer so that 0.5 V rms appears at its wiper. Close $S1$, but do not disturb the settings of $S2$, $S3$, and $S4$. Connect the signal source to the free end of the wire

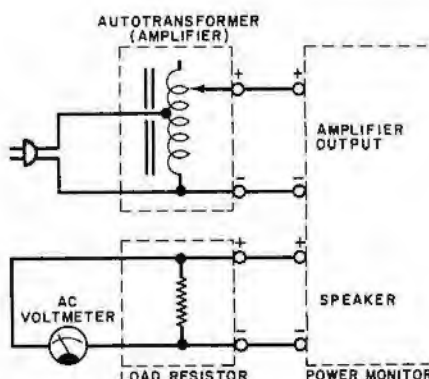


Fig. 7. Connections required for calibration of meter driver and the comparator string.

which you disconnected from $R1$. Now adjust the Y_0 trim $R9$ for the lowest reading obtainable on the meter. Then disconnect the signal source and remove power from the project. Reconnect the wire to $R1$.

Place $S3$ in its AVERAGE position, close $S1$, and readjust $R10$ for zero on the meter. Remove power from the project and disconnect the wires grounding the right channel's AMPLIFIER OUTPUT terminals. The multiplier IC is now trimmed for optimum accuracy.

The meter driver and comparator string can now be calibrated. There are three items necessary to perform these calibrations. The first is a variable autotransformer, usually referred to by the trade name Variac. The transformer

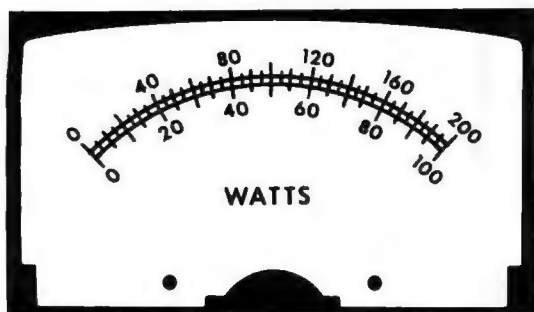


Fig. 8. Using this modified scale for your meter for operation up to 200 watts.

should be capable of supplying up to 50 V ac at 3.2 A. If such a transformer is not available, you can use a signal generator (or 6.3-volt ac filament transformer and 500-ohm potentiometer) and an audio amplifier capable of delivering 100 watts or more per channel of unclipped audio power into a 10-ohm load.

A wirewound load resistor is also needed. The type of power resistor most readily available is usually inductively wound; and at higher frequencies, the inductive reactance causes problems. Therefore, calibration is carried out at 60 Hz, where the effects of reactance are negligible. However, if you want to verify the project's accuracy at a higher frequency—say 1000 Hz—you should obtain a 10-ohm, 100-watt noninductive power resistor.

Also necessary for calibration is an accurate ac voltmeter. The value of the nominal 10-ohm load resistor should be known as accurately as possible, preferably to within 1%. Calibration will use the relationship $P = E^2/Z$. Any error in voltage will be squared when converted to a power value. Thus, an accurate voltmeter is critical. A 3½- or 4½-digit DMM is preferred for its superior resolution.

Line-powered autotransformers present a potential shock hazard. If possible, plug the autotransformer into an isolation transformer to reduce the likelihood

of shock. Otherwise, remember that your power monitor is floating above ground—and be careful!

For calibration, the variable transformer assumes the role of power amplifier and the power resistor that of the speaker. (As mentioned earlier, a power amplifier driven by a source of 60-Hz ac can be employed.) Interconnect the various components, as shown in Fig. 7. Set S2 to the position corresponding to the channel you are using for calibration (either will do). Set S3 to AVERAGE, S4 to 20 w, and S1 to ON. You will be reading the power from the 0-to-20-watt scale.

Adjust the transformer (or amplifier) for a voltage equivalent to a 20-watt power level (14.1 volts rms across a 10-ohm load). Then adjust trimmer R34 so that the meter reads 20 watts. Lower the voltage to equal 10 watts of power through the load (10.0 volts rms). If the meter does not read exactly 10 watts, the movement is slightly nonlinear. In that case, adjust R34 for equal error at 10 and 20 watts.

With the transformer set for a power reading of 10 watts average, set S3 to PEAK. The power meter should now read 20 watts peak. Now adjust R14 so that all four LED peak indicators begin to glow simultaneously. Vary the transformer to verify that each level indicator comes on at its appropriate threshold as indicated by the power meter. Note that, for a sine wave, the peak power at any given voltage level is twice the average power at that same voltage level. Voltages corresponding to various power levels are given in the Table at right.

Repeat the above calibration procedure for trimmer potentiometers R13 and R33 with the range select switch set to 100 w.

In Conclusion. Now you are ready to hook up the True Audio Power Meter to your stereo system. The values of current-sense resistors R1 and R2 have been kept low to prevent audible degradation of the audio system's damping factor, although purists might raise eye-

brows at the introduction of the resistance between the amplifier and speaker. Practically speaking, however, the effect of this small series resistance is not significant. Note that channel selector S2B connects one end of the selected current-sense resistor to project ground. To avoid shorting out the loudspeaker and damaging the sense resistor (and possibly the amplifier), make sure that the project ground is kept isolated from the amplifier or system ground if the amplifier's "hot" output is referenced to ground or returns to ground through a low-impedance path.

Unless you have a very powerful amplifier, very inefficient loudspeakers, and a penchant for very loud listening levels, you will probably find 100 watts to be more than adequate full-scale readings. However, should you desire to display higher power levels, you can easily

TABLE OF POWER VS. VOLTAGE
ACROSS 10 OHMS

Power (watts)	Volts	
	Peak	Average
5	5.0	7.1
10	7.1	10.0
15	8.7	12.2
20	10.0	14.1
25	11.2	15.8
50	15.8	22.4
75	19.4	27.4
100	22.4	31.6
150	27.4	38.7
200	31.6	44.7

modify the power monitor to read 200 watts full-scale by making the following changes in component values: change R4 to 2700 ohms and R6 and R12 to 10,000 ohms. You will have to make a new scale for your meter and calibrate it accordingly. A paste-on meter scale for 100-watt/200-watt operation is given in Fig. 8. If the 20-watt scale is replaced with a 100-watt scale, you will probably find it easier to calibrate the comparator string if you change the value of R14 to 25,000 or 50,000 ohms.

Relating linear power measurements to listening levels is not easy or necessarily meaningful. Furthermore, the speaker is not uniformly efficient across its bandpass, so that 10 watts, say, represents different sound-pressure levels at different frequencies. The monitor does, however, keep track of the power your speakers are forced to dissipate, so that you can avoid driving them too hard for too long. ◇



In prototype, resistors R1 and R2 are stacked at rear of pc board.

fact:

we've put a NEW plus into the Super-Track Plus family of V15 Type III Cartridges



Hyperelliptical tip for audibly greater freedom from distortion

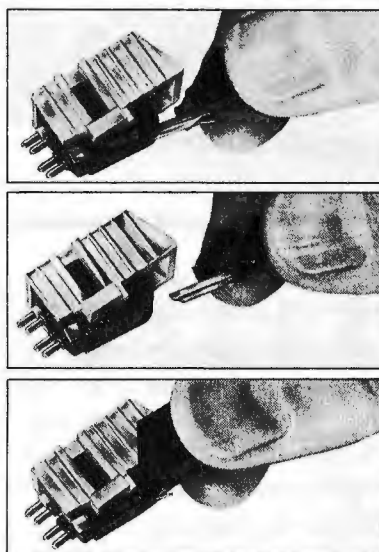
One of the critically acclaimed developments introduced in Shure's incomparable V15 Type IV phono cartridge is its revolutionary distortion-reducing Hyperelliptical nude diamond tip. It established a new standard of sound purity through a dramatic reduction of both harmonic and intermodulation distortion. Now, the Hyperelliptical tip is also available in the world-famous V15 Type III Super-Track Plus Cartridge, bringing together the sound purity and flat response of the IV at an eminently affordable price. It is truly second only to one other cartridge in the world—the V15 Type IV.

V15 TYPE III-HE

Stereo Dynetic® Phono Cartridge

If you already own a V15 Type III you can upgrade it!

If you are one of the thousands of audiophiles who already own a V15 Type III, you too can benefit from the new freedom from distortion afforded by the Hyperelliptical stylus. Simply replace your present stylus with the new VN35HE improvement stylus. It will give your Type III cartridge the same specifications as the new V15 Type III-HE. The cost is extraordinarily low, yet the difference in sound will be immediately apparent. Takes only seconds to install (see illustration), requires no tools whatsoever.



V15 TYPE III-HE IMPROVEMENT STYLUS



Shure Brothers Inc., 222 Hartrey Ave., Evanston, IL 60204, In Canada: A. C. Simmonds & Sons Limited
Outside the U.S. or Canada, write to Shure Brothers Inc., Attn: Dept. J6 for information on your local Shure distributor.
Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

CIRCLE NO. 52 ON FREE INFORMATION CARD

Train with NTS for the MicroComputers, digital the first name



MicroComputers

The world of electronics is daily becoming more challenging. Technology is growing more specialized, and the importance of digital systems increases every day. Test instruments, home entertainment units and industrial control systems are all going digital. And now, NTS training programs include a wider choice of solid-state and digital equipment than ever before offered in any home study course: Advanced NTS/Heath digital color TV (25" diagonal with optional programming capability), NTS/Heath microcomputer, digital test equipment, digital stereo receiver (70 watts per channel), NTS compu-trainer, plus much more state-of-the-art equipment to make your training exciting and relevant.

The equipment you receive with NTS training programs is selected to provide you with a solid

background in electronic systems. Kits and lessons are designed to work together to demonstrate electronic principles and applications. The kit-building not only shows you how electronic hardware functions, but how various circuit designs accomplish different purposes. Your lessons guide you through any number of experiments associated with many projects. This is the Project-Method, and it works. Step-by-step, you learn how and why digital electronics has become a part of our world, and the even bigger role it is sure to play in the future.

Whether you are looking for training in Consumer, Commercial, or Industrial electronics, NTS offers fourteen courses, some basic, many advanced, in several areas of electronics. An all-new full-color NTS catalog shows you what each course covers,



Send a card. Start a career.

NTS' project-method courses can start you on a new, exciting career. Learn Electronics with our new GR 2001 computerized color TV (25" diagonal), with optional programming capability. NTS also has courses in Air Conditioning, Mechanics, Home Appliances. Send this card. We'll rush you our new full-color catalog. All absolutely free. **NO OBLIGATION, NO SALESMAN WILL CALL.**

NTS guide
to careers in
Electronics

ELECTRONICS DIVISION

- | | |
|---|---|
| <input type="checkbox"/> Color TV Servicing | <input type="checkbox"/> Electronics Technology |
| <input type="checkbox"/> B&W TV and Radio Servicing | <input type="checkbox"/> Computer Electronics |
| <input type="checkbox"/> FCC License Course | <input type="checkbox"/> Audio Electronics Servicing |
| <input type="checkbox"/> Basic Electronics | <input type="checkbox"/> Digital Electronics |
| <input type="checkbox"/> Electronic Communications | <input type="checkbox"/> MicroComputers/
MicroProcessors |

MECHANICS DIVISION

- ☐ Master Course in Auto, Truck & Diesel Mechanics
- ☐ Automotive Mechanics
- ☐ Engine Tune-Up and Diagnostic Analysis

AIR CONDITIONING, REFRIGERATION, HEATING DIVISION

- ☐ Master Course in Air Conditioning, Refrigeration & Heating

HOME APPLIANCES DIVISION

- ☐ Home Appliance Master Technician's Course
- ☐ Handyman Appliance Repair
- ☐ Approved for Veteran Training. Check for details.
- ☐ Check if interested **ONLY** in classroom training in Los Angeles.

205-109

Name _____ Age _____

Address _____

Apt. _____ City _____

State _____ Zip _____

NATIONAL TECHNICAL SCHOOLS

Technical-Trade Training Since 1905. Resident and Home-Study Schools.
4000 S. Figueroa St., Los Angeles, Calif. 90037



NO POSTAGE
NECESSARY IF
MAILED IN THE
UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS Permit No. 3087 Los Angeles, California

POSTAGE WILL BE PAID BY ADDRESSEE

NATIONAL  **SCHOOLS**

**4000 South Figueroa Street
Los Angeles, California 90037**



electronics of the future.

systems and more...from
in home study.

and every piece of equipment included.

Send for it today, and see for yourself what's really happening in electronics training technology at NTS. Find out how much has changed, and what new directions the field is taking. You'll probably want to be a part of it.

It's free. Just mail the card or coupon. Today.

**NO OBLIGATION. NO SALESMAN WILL CALL.
APPROVED FOR VETERAN TRAINING.**

NATIONAL TECHNICAL SCHOOLS

TECHNICAL-TRADE TRAINING SINCE 1905
Resident and Home-Study Schools
4000 South Figueroa St., Los Angeles, Calif. 90037

NATIONAL TECHNICAL SCHOOLS Dept. 205-109
4000 South Figueroa Street, Los Angeles, California 90037

Please send FREE Color Catalog and Sample Lesson.

- ☐ Color TV Servicing
- ☐ B & W TV and Radio Servicing
- ☐ FCC License Course
- ☐ Electronic Communications
- ☐ Electronics Technology
- ☐ Audio Electronics Servicing
- ☐ Digital Electronics
- ☐ MicroComputers/MicroProcessors

Name _____

Address _____

Apartment Number _____ Age _____

City _____

State _____ Zip _____

☐ Check if interested in G.I. Bill information.

☐ Check if interested ONLY in classroom training in Los Angeles.

Dial your scores into a two-player, double-digit scoreboard

GAMES in which the scores for individual players must be kept are a popular pastime. Not so popular is the usual search for paper and pencil needed for keeping the score. The Electronic Scorekeeper described here eliminates the search so you can get right to the game. As designed, the Scorekeeper can keep score for two players up to a maximum count of 99. However, with a couple of simple modifications, the number of players and the count range can be increased as desired. The circuit uses readily available and inexpensive TTL devices and seven-segment numeric LED displays.

About the Circuit. Since the circuit for each player is identical, only the circuit for player A is shown in Fig. 1. Player B's circuit connects to the pin-6 output of gate IC1B. Integrated circuits IC4 and IC5 and display DIS2 make up a conventional 0-to-9 units decade counter whose carry output at pin 8 of IC4 is fed to a similar tens counter made up of IC2, IC3, and DIS1. Seven-segment displays DIS1 and DIS2 are common-anode LED types.

The count for the circuit shown in Fig. 1 can easily be increased as desired simply by adding extra decade counters. When the additional decade counters

are used, the input of each successive counter is connected to the carry output of the preceding counter and the RESET lines are connected in common.

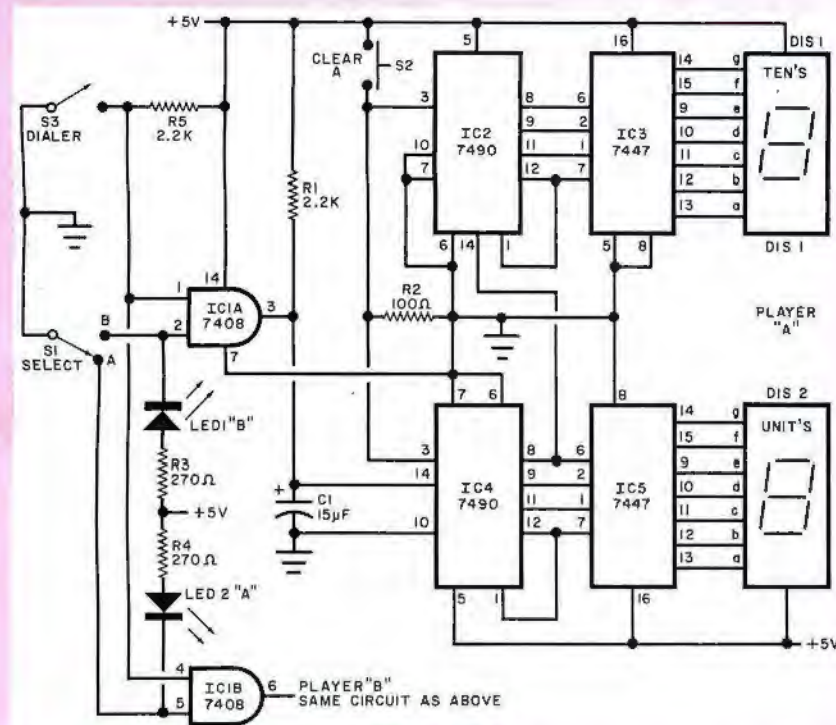
Both decade counters shown in Fig. 1 are set to zero by operating CLEAR push-button switch S2 to momentarily raise the reset-to-zero (RST) input at pin 3 of IC2 and IC4 to high and then back to ground as the switch is released and pulldown is accomplished by R2. When S2 is pressed and released, both DIS1 and DIS2 should display zeros.

SELECTOR switch S1 permits the person keeping score to choose between player A and player B for score display

Electronic Scorekeeper for Recreation Rooms

BY JOSEPH FORTUNA





PARTS LIST

C1—15- μ F, 15-volt electrolytic
DIS1, DIS2—Common-anode 7-segment LED display
IC1—7408 quad AND gate
IC2, IC4—7490 decade counter
IC3, IC5—7447 BCD-to-7-segment decoder
LED1, LED2—Any discrete red LED
R1, R5—2200-ohm, $\frac{1}{2}$ -watt resistor
R2—100-ohm, $\frac{1}{2}$ -watt resistor
R3, R4—270-ohm, $\frac{1}{2}$ -watt resistor

S1—Dpst switch
S2—Normally open pushbutton switch
S3—Telephone dialer-switch mechanism (see text)
Misc.—Duplicate circuit for player B; regulated 5-volt, 1-ampere dc power supply; perforated or printed-circuit board and hardware; suitable enclosure; sockets for ICs (optional); machine hardware; hookup wire; solder; dry-transfer lettering kit; etc.

pulses, depending on the DIALER number selected, for player A's decade counter. (This assumes S1 is set to A; operation is identical for player B, except that S1 must be set to B.) Every time the IC4 units decade overflows at the tenth pulse from IC1A, the carry output from IC4 toggles the IC2 decade counter.

The circuit in Fig. 1 can be expanded to keep score for more than two players, as shown in Fig. 2. Note here that separate player LEDs are not used. Using the AND gate and truth table shown, you can design further switching to increase the number of players beyond the three shown in Fig. 2.

Construction. Since component layout is not critical, you can use just about any wiring technique that suits you. Perhaps most convenient is a printed-circuit board of your own design, but perforated board and Wire Wrapping is equally suitable. In either case, it is recommended that you use sockets for the ICs.

Once you have assembled and checked the circuit, mount it in an enclosure so that the two pairs of displays can easily be viewed. Mount the LEDs and switches, including the DIALER mechanism, on the top of the enclosure. Finally, use a dry-transfer lettering kit to label the switches and LEDs according to function.

Power for the Scorekeeper can be obtained from any regulated 5-volt dc supply capable of delivering 1 ampere or more of current. \diamond

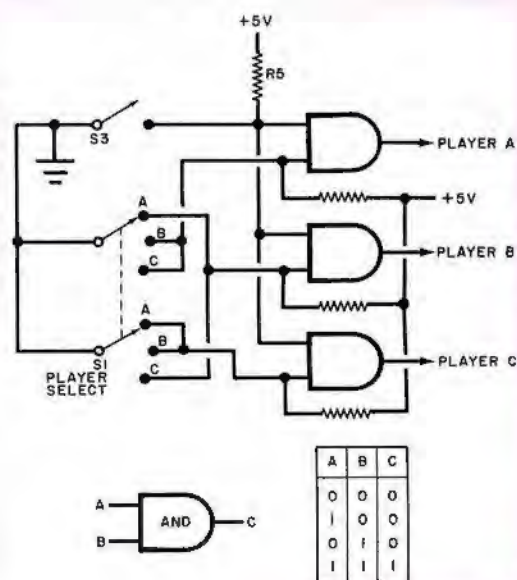
Fig. 1. Schematic shows scorekeeping circuit for only one player.

and incrementing. When the player-A position is selected, pin 5 of IC1B is grounded and held low, causing LED2 for player A to come on. At this time, the output of IC1B is low and the gate is disabled. Hence, the player-B decade counters will not operate.

Pin 1 of IC1A and pin 4 of IC1B are made high by pullup resistor R5, and mechanical DIALER switch S3 is connected from ground to this common point. (A surplus mechanical telephone-dial switch assembly can be used for S3 to allow you to conveniently "dial in" the score updates. Alternatively, you can substitute an ordinary normally open pushbutton switch for this operation, but it will have to be operated for each and every unit increment in the scoring.)

Operating S3 shorts the common IC1A pin-1 IC1B pin-4 point to ground the same number of times selected on the DIALER. As the DIALER is operated, IC1A turns on and off with each closure of S3. This generates one or more input

Fig. 2. A scorekeeper for more than two people can be made by using AND gates and switching as shown here as long as truth table is satisfied.



ACCURATE TIMEBASE FOR DIGITAL ELECTRONIC CLOCKS

Inexpensive circuit maintains digital counting automatically when power is lost.

IF YOU OWN a digital clock, its likely you expect it to maintain extremely high accuracy, especially if it displays seconds. Digital clocks, however, have a special problem not found in the ordinary electromechanical clock.

The problem is caused by a momentary power outage, lasting a second or two, that may occur at any time of the day or night. This outage may be brief enough to produce only a flicker of the display, yet brief as it is, the clock's digital counter circuit can generate a timing error. An electro-mechanical clock will integrate the outage and the clock dial may skip a second or so, with no real harm done.

The timebase described here is designed to overcome the problem in digital timekeeping and, in doing so, virtually eliminate the inaccuracies commonly encountered.

Power Line Vs. Crystal. If the ac power-line frequency is measured at any given instant, its frequency might vary from exactly 60 Hz by as much as 0.03%. This is the accuracy over the short term. The long-term accuracy, however, is actually much better than this by several magnitudes, as we shall see. A digital clock powered from a hypothetical glitch-free, uninterrupted commercial power line might show an error of only two or three seconds a year. Since there are 3.15×10^7 seconds in a year, this works out to an accuracy of better than $\pm 0.00001\%$, a far cry from the $\pm 0.03\%$ specified.

This seeming paradox is resolved by the fact that the power-line frequency is periodically corrected to a frequency standard so that its long-term average frequency is maintained close to exactly 60 Hz.

Unlike an electromechanical clock

whose mechanical inertia makes it extremely forgiving of glitches and transients, a digital electronic clock depends upon an uninterrupted, glitch-free timebase. Interrupt the timebase, even momentarily, and the clock loses its count. This is why filters and a large filter capacitor cannot do a complete job of maintaining accuracy during momentary power dropouts. Fast transients can be attenuated and the operating dc voltage can be maintained but there is no way to maintain the 60-Hz counting line frequency when power is interrupted.

The glitch problem is severe and has prompted many designers to turn to the crystal timebase, contrary to popular belief, is not a perfect cure for the problems mentioned above. Most crystals available to the hobbyist have rated accuracy of $\pm 0.001\%$ to $\pm 0.005\%$, which is better than the short-term accuracy of the power line but nowhere near its long-term accuracy. Also, over the long haul, all crystals age. Hence, unless a crystal timebase is periodically recalibrated, this slow frequency drift adds to decreasing accuracy. Needless to say, going to a crystal timebase provides glitch-free operation and improved short-term accuracy but at the expense of greatly deteriorated long-term accuracy.

The low-cost Digital Clock Timebase, shown in Fig. 1 wired to part of a typical digital clock, uses the best of both techniques to meet all our requirements for an ideal timebase. It uses the power-line as the primary timebase for long-term accuracy. When a glitch or power outage is detected, two things occur. First, there is a rapid transfer to a crystal-controlled 60-Hz standby timebase, which takes over for the duration of the glitch. Second, smooth transfer is made to battery backup power when the power-supply filter capacitor in the clock can no longer support the system. The circuitry that does all this is low-power CMOS for minimum battery drain.

BY WILLIAM D. KRAENGEL

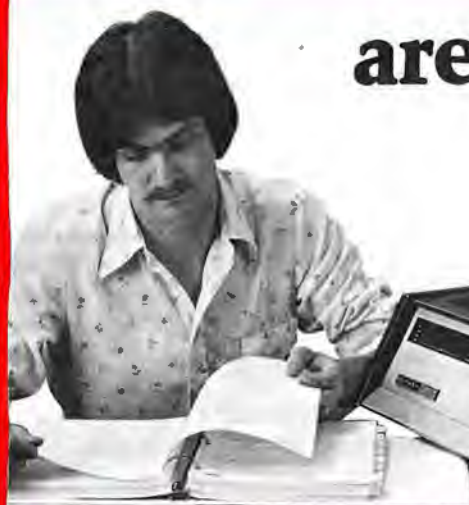
How It Works. The two functions of the timebase are shown in Fig. 1. When the clock's +V supply drops low enough to forward bias *D2*, rechargeable backup battery *B1* smoothly takes over. Battery *B1* also supplies V_{DD} for the standby timebase. The useful charge of the battery is extended if the clock's display and other nonessential loads are blanked when operating from the battery. Diode *D1* isolates these loads so they operate only from the clock's built-in power supply.

During a momentary power outage, the filter capacitor may not discharge to the transfer point immediately. Since the power-line counting frequency is lost for the entire duration of the outage, a faster way to sense power outages must be used, a function provided by *IC2*.

Retriggerable monostable multivibrator *IC2* is configured as a missing-pulse detector whose output pulse width (at pin 7) is set for 20 ms or slightly greater than the period of the 60-Hz line frequency. The detector is triggered once at the beginning of each cycle by the differentiated output of Schmitt trigger *IC1A*. Input to the trigger is the same 60-Hz primary timebase input to the clock *IC*. Since the detector cannot time out, its output remains low, keeping gate *IC1B* disabled. The output of gate *IC1B* is inverted by *IC1C*, sending a logic 0 to the OR gate.

During a glitch or other power outage, the line frequency, (and, hence, the retrigger pulse) lapses. Detector *IC2* is now free to complete its cycle to time out 3.3 ms after not receiving a retrigger pulse. Its output then goes high and enables *IC1B* to apply the standby *IC3* crystal-controlled 60-Hz timebase to the clock.

Crystal-controlled oscillator/divider *IC3* continuously generates 60 Hz from a commonly available 3.58-MHz color-TV oscillator crystal. When enabled by the detector, *IC1B* gates the standby timebase to the high-level OR gate made up of *D3*, *D4*, and *R5*. Either the high-level half-sinusoid primary timebase or the CMOS-level square-wave standby timebase is then gated to the 50/60-Hz input of the clock *IC*.



are you looking for ways to get the most from your computer?

Let the easy-to-use
**Heathkit® Computer
Language Programs**
show you the way!

Heathkit Assembly Language Programming Self-Instruction Program.

- Use the full capacity of your computer system
- Execute computer programs *much* faster
- Store more information in less memory space

Assembly Language, the most powerful and versatile language you can use, enables you to do **anything** your computer system is capable of doing. It puts you in **total command** of your computer.

Codes are shorter and more explicit in Assembly Language, which means your computer system's memory can be used more efficiently.

Every computer system operation has a mnemonic in Assembly Language. Your computer programs can run much faster, since you waste no time interpreting them.

You can learn how to program your computer system in Assembly Language with the help of the Heathkit Assembly

Language Programming Self-Instruction Program. Learn at your own pace through a special text designed for self-study. An exercise workbook provides hands-on experience to back up the special text, with programming exercises performed by you on your computer. You'll find the learning fast, fun and thorough.

The Heathkit Program is designed for computer systems using the popular 8080/8085 microprocessor series, and the popular Heathkit Z80 microprocessor. But concepts of the program can be applied to any computer.

The time has never been better to learn the language that puts your computer's full potential within your reach. Send your order today for the Heathkit Assembly Language Programming Self-Instruction Program and put yourself in the driver's seat!

Order No. EC-1108: \$49.95, plus \$2.60 shipping & handling.

Heathkit BASIC Language Programming Self-Instruction Program.

- The easiest of all computer languages to use
- Now the easiest of all languages to learn

BASIC is the easiest computer language to learn and to use, because it uses English statements and commands. And more programs are written in BASIC than in any other language.

With a working knowledge of BASIC, you can adapt and run hundreds of existing programs. You can exchange programs with others. And you can write new programs, tailored to your specific requirements.

Send Today or Phone (616) 982-3411 for faster service on Heath Revolving Charge, VISA or Master Charge.

The Heathkit Self-Instruction Program covers all the formats, commands, statements and procedures in 14 easy-to-follow segments. A special workbook provides programming instructions and experiments to perform on your own computer. And you'll learn practical, problem-solving techniques.

You're missing the full range of programs available to you until you learn BASIC Language. Send today for the Heathkit BASIC Language Programming Self-Instruction Program.

Order No. EC-1100: \$39.95, plus \$2.40 shipping & handling.

Heath Company, Dept. 010-582, Benton Harbor, MI 49022

HEATH

Schlumberger

Heath Company
Dept. 010-582
Benton Harbor, MI 49022

SHIP MY ORDER TO:

Name _____ (please print)

Address _____

City _____ State _____

Zip _____

PLEASE RUSH ME:

- ☐ Assembly Language Self-instruction Program
EC-1108 \$49.95, plus \$2.60 shipping & handling.
- ☐ BASIC Language Self-instruction Program
EC-1100 \$39.95, plus \$2.40 shipping & handling.

Total price

Michigan residents add

4% sales tax

Add shipping & handling Total shipping & handling

Total

Enclosed please find ☐ check ☐ money order for \$

or charge to my ☐ Heath Revolving Charge ☐ VISA ☐ Master Charge: Code #

Acct. # Exp. Date

Signature (necessary to send merchandise)

Prices are mail order and subject to change without notice. ED-130

MONEY-BACK GUARANTEE OF SATISFACTION

If you are not completely satisfied with the EC-1100 BASIC Program or the EC-1108 ASSEMBLY Program, simply return programs for a full refund of purchase price.

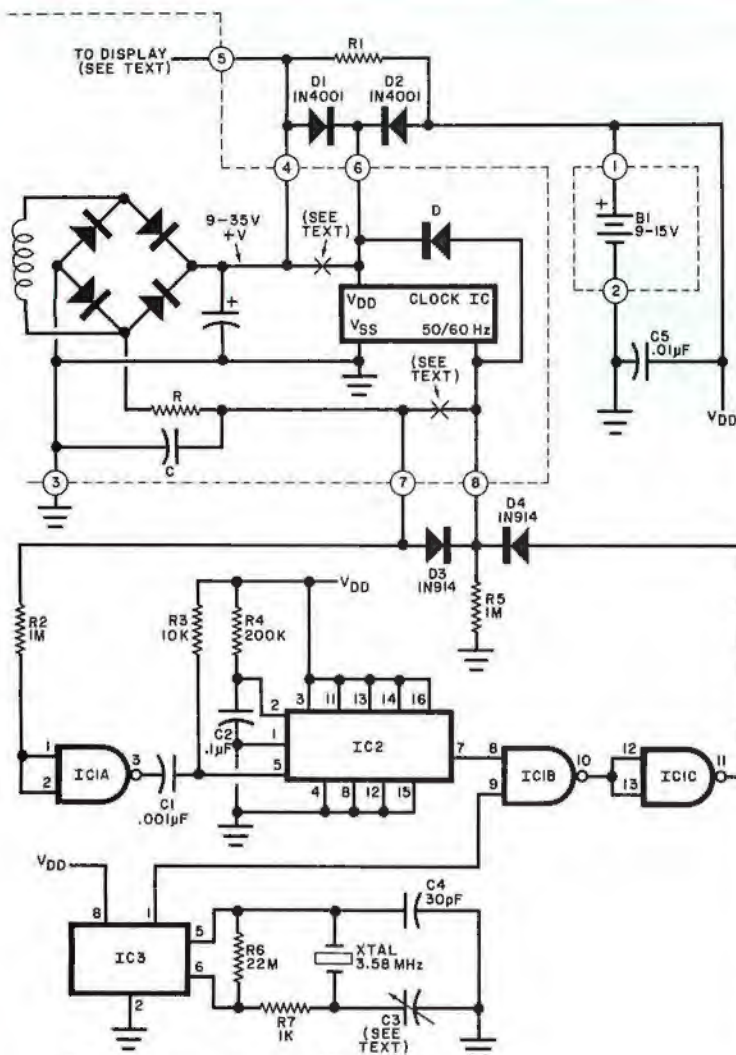


Fig. 1. In power outage, digital counter and rechargeable battery power supply automatically take over.

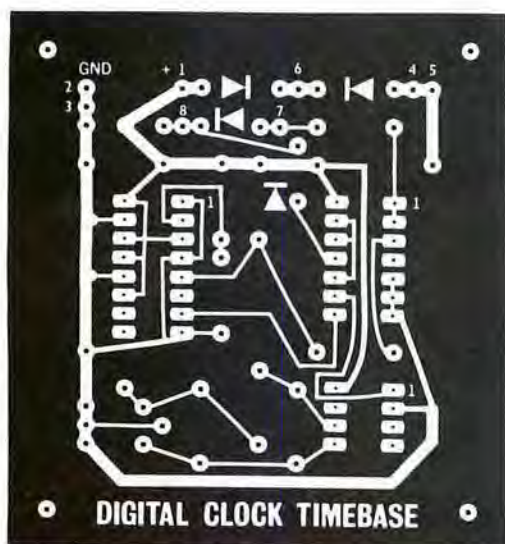


Fig. 2. Actual-size etching and drilling and component placement guides for Digital Clock Timebase.

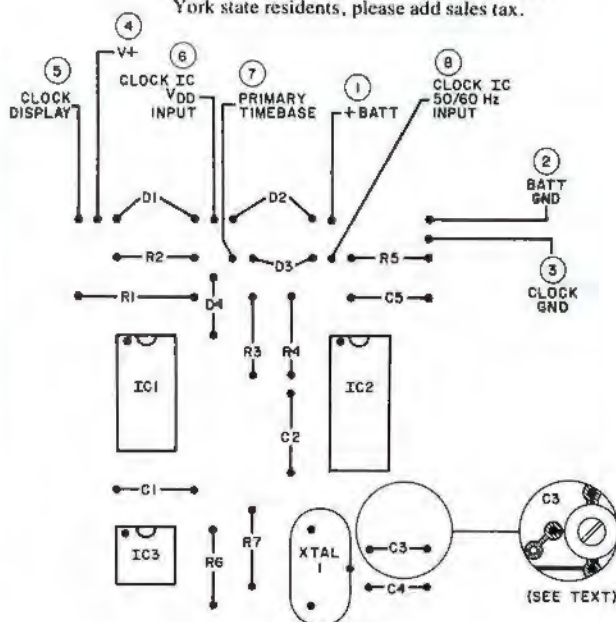
When primary power returns, almost a reverse action occurs. As the filter capacitor in the clock recharges, it again crosses the transfer point. Then the glitchless transfer is back to the power supply. The primary timebase, rising in step with the filter capacitor voltage, is gated to the 50/60-Hz input of the clock IC and to detector IC2 via Schmitt trigger IC1A. The detector output immediately goes low, disabling gate IC1B to remove the standby timebase.

Construction. The timebase is best assembled on a printed-circuit board,

PARTS LIST

- B1—9-to-15-volt rechargeable battery (see text)
- C1—0.001- μ F, 50-V disc ceramic
- C2—0.1- μ F, 50-V Mylar
- C3—20-pF, 50-V disc ceramic or 10-40-pF trimmer, see text
- C4—30-pF, 50-V, disc ceramic
- C5—0.01- μ F, 50-V, disc ceramic
- D1, D2—1N4001
- D3, D4—1N914
- IC1—4093B Schmitt trigger
- IC2—MC14538B dual monostable (Motorola)
- IC3—MM5369 oscillator/divider (National)
- R1—see text
- R2, R5—1-megohm, $\frac{1}{4}$ -W resistor
- R3—10,000-ohm, $\frac{1}{4}$ -W resistor
- R4—200,000-ohm, 5%, $\frac{1}{4}$ -W resistor
- R6—22-megohm, $\frac{1}{4}$ -W resistor
- R7—1000-ohm, $\frac{1}{4}$ -W resistor
- XTAL—3.58-MHz, color-TV oscillator crystal
- Misc.—IC sockets or pins, battery holder, etc.

Note: The following is available from CM Circuits, 22 Maple Ave., Lakawanna, NY 14218: etched and drilled pc board at \$3.25, plus \$0.50, postage and handling. New York state residents, please add sales tax.



but other wiring methods can be used. Illustrated in Fig. 2 are both the etching-and-drilling and component-placement guides. Sockets for the ICs are optional but highly recommended. The circled numbers in the schematic correspond to input/output points on the pc board.

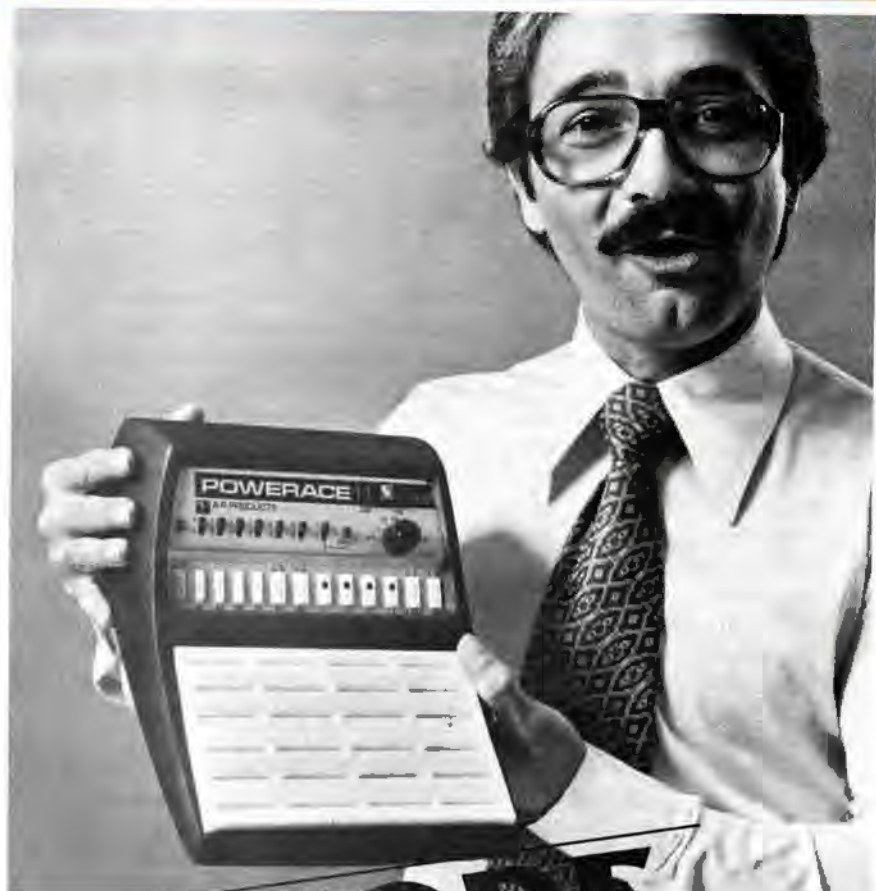
The value of $R1$ to be used in your system is calculated by Ohm's Law. For example, suppose your power supply has an output of 25 volts and you have previously determined that a 12-volt nickel-cadmium-cell with a capacity of 0.5 ampere-hour (AH) will do for backup. The battery is trickle-charged at a hundredth of the rated battery capacity, which in our case is 5 mA. Using the formula (power-supply voltage minus battery voltage) divided by (desired charging current plus standby timebase operating current), we obtain $(25 - 12) / (0.005 + 0.0025)$, or 1733.3 ohms. You would then use an 1800-ohm (nearest standard value) resistor for $R1$. Determining the power rating of $R1$ by I^2R reveals that a standard 1800-ohm, 1/4-W resistor will do nicely.

When selecting the backup battery to be used, keep in mind that many clock ICs will keep time at a lower potential than the minimum operating voltage specified on the data sheet as long as the display is not driven. (Mount the battery off the pc board.)

Installation. In the typical digital clock shown in Fig. 1, the clock chip's 50/60-Hz timebase input is usually filtered by RC and clamped to V_{DD} by diode D . Break this line as shown and wire it to gate input 7. Wire gate output 8 back to the 50/60-Hz input of the clock IC. Note that the timebase will keep accurate time only for 60-Hz systems.

The +V output from the filter capacitor usually drives all circuitry directly. Break this lead as shown and wire it to gate input 4. Reroute the display and other nonessential wiring to gate input 5. Wire gate output 6 back to the V_{DD} inputs of the clock IC and other essential circuitry.

Calibration. The accuracy of the crystal is usually much greater than the instantaneous accuracy of the 60-Hz line frequency. For most purposes this accuracy will suffice, but for those who want a more accurate calibration and have access to an accurate frequency counter, the oscillator frequency can be trimmed to exactly 60 Hz. Replace fixed capacitor $C3$ with a 10-to-40-pF trimmer capacitor and adjust until pin 1 of $IC3$ shows exactly 60 Hz on the counter. ◇



This A P power breadboard includes a pulse detector, complete with memory.

Now that you're ready to build and test more sophisticated circuits, you've found the right breadboard.

Our Model 102 A P POWERACE, for instance, gives you a complete digital prototyping lab in one compact package.

It will detect positive or negative-going pulses as short as 10 nanoseconds—and keep them on-tap for you in its memory. This, combined with its 3 logic indicators, gives you a built-in logic probe.

Like our other power breadboards, the 102 has 16 distribution buses of 25 tie-points per bus to jumper in groups as needed and use for voltage and ground distribution, reset lines, clock lines, shift command, etc. And 1,680 tie-point terminals for plugging in circuit components and jumper wires.

With an A P POWERACE, you will prototype any type of electronic circuit faster and easier than you ever thought possible.

Your A P dealer has the details. Where? We'll tell you. Call (toll-free) 800-321-9668. And ask for the complete A P catalog, The Faster and Easier Book.



**A P PRODUCTS
INCORPORATED**

Box 110 A • 72 Corwin Drive
Painesville, Ohio 44077
Tel. 216/354-2101
TWX: 810-425-2250

Faster and Easier is what we're all about.

HOW TO Improve SW Receiver Tuning Accuracy

BY JAMES L. HALL

Frequency plotting on graph paper enables you to pinpoint frequencies within 5 kHz on inexpensive receivers

WITH MORE than 140 international radio services beaming English language programming to North America each week, SWL's have ample opportunities to bag some real DX. Seasonal propagation offers the shortwave listener a wide variety of DX from all over the world. And serious SWLs are never content to log only the super power stations such as Radio Moscow or the BBC External Services. They check frequency lists and broadcast times, and track the big DX Game.

Unfortunately, the DX hunter possessing an inexpensive receiver with poorly marked and inaccurately calibrated tuning dials has difficulty locating precise frequencies. Main tuning dials are marked for general frequency coverage and will put you in the DX hunting areas, but that's about all. Bandspeed offers little help since interval indicators are meaningless without correlations with main tuning. How can you find DX with inexpensive receivers? Frequency plotting is the answer. By preparing simple frequency charts on common graph paper, you can track DX frequencies within a 5-kHz range.

Chart Preparation. A frequency calibrator, common graph paper, and a straight edge are all the materials you

need for the project. If you don't have access to a frequency calibrator, take your receiver to a radio-TV repairman and have him align the tuning dials in 100-kHz increments. Age, moisture and dust can cause problems with belt-driven tuning mechanisms. Consequently, most receivers need periodic alignment. Also, this frequency plotting procedure is for linear-pattern tuning and not log-scale tuning. Most receivers will be clearly marked for tuning scale type. If in doubt, ask a radio-TV repairman to examine your receiver. He should be able to determine the tuning pattern by inspection.

Select graph paper with quadratic coordinates (x for horizontal and y vertical) for the frequency plots. It can be purchased at most office and school supply stores. If you cannot obtain quadratic paper, you can use any other linear graph paper. Simply strike accented lines horizontally and vertically across the center and down the middle. Label the horizontal line $-x$ on the left and x on the right and the vertical line y on the top and $-y$ on the bottom.

Now you are ready to track a DX frequency. Check frequency and broadcast times for the DX station you wish to locate on your receiver. There are several listings available but the most widely

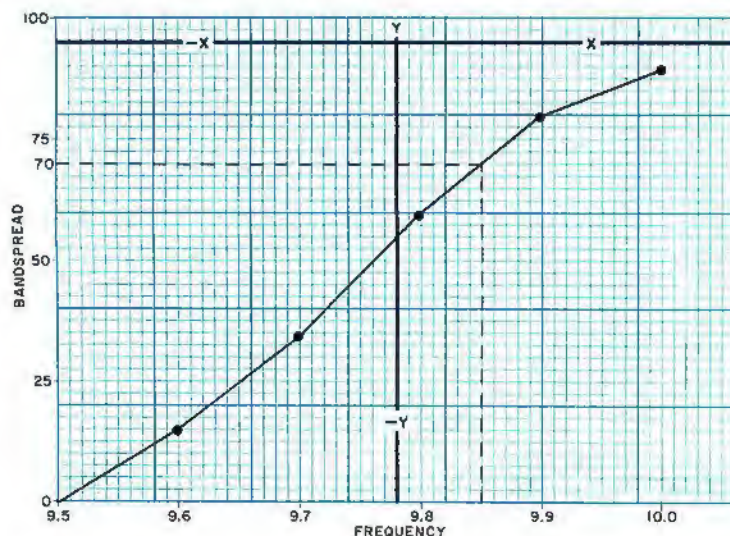
recognized single source is the annual World Radio TV Handbook.

Calibration Alignment. Suppose you find a listing for a DX service operating on 9.85 MHz. Use the following procedure to find 9.85 MHz on your receiver. Connect the calibrator to the receiver at the antenna terminal and turn on both. Set the bandspeed to zero and tune the receiver to the calibrator signal at the low edge of the band. For this example, 9.5 is a good starting point.

Referring to the sample plot shown here, place the graph paper on a flat surface. Label the bottom left corner 0 and 9.5. Write "Frequency" in the bottom margin and "Bandspeed" in the left margin. Next, tune the bandspeed until you hear the next calibrator signal and record the interval number. The calibrated frequency is 9.6 and the corresponding bandspeed marking for this example is 15. Continue this procedure until the bandspeed has been covered or until the entire grid has been calibrated. Draw a line from 9.5 to 10.0.

Plotting Frequencies. Examine the frequency range on your graph. The DX station will be broadcasting on 9.85 MHz. By inspection, this point is located half-way between 9.8 and 9.9 MHz. With a straight edge, draw a vertical line from the 9.85 point until it intersects the calibrated frequency plot line. Then, from the point of intersection, draw another line parallel with the frequency base until it intersects the bandspeed's vertical axis. Read the bandspeed mark on the graph, which is, for this example, 70. The bandspeed indicator (70) corresponds to 9.85 MHz.

Prepare charts for the remaining frequency ranges for the international broadcast bands by following the calibration procedure. By plotting frequencies and correlating them to your receiver's bandspeed markings, you can locate any frequency in the international bands. Check a frequency list and broadcast times for a DX station. With patience and careful frequency tracking, your DX hunt will be successful. ◇



Sample plot of frequency vs. bandspeed for locating a DX station.

Classic Companions.



Realistic's System Seven... new size, new shape, compact without compromise

Cheers to "mini" styling!

Realistic's fabulous System Seven combines beauty, elegant small size and a level of acoustical quality you've never heard, until now, in low-priced bookshelf stereo.

System Seven includes our STA-7 AM/FM receiver (10 watts per channel, minimum RMS into 8 ohms, 20-20,000 Hz, with no more than 0.4% total harmonic



At last—true hi-fi perfectly sized for a bookcase. The 4-1/3-lb. speakers can even be used for bookends!

distortion) and a pair of our amazing Minimus®-7 speaker systems—featuring large-excursion woofers and soft-dome tweeters in diecast enclosures only 7 1/16" high.

Bass without bulk. Despite its small size, System Seven delivers rich, satisfying bass to 50 Hz and sound levels up to 90 dB for accurate reproduction of anything from classical to rock music. What's the secret? The receiver has a unique equalization network engineered especially for mini speakers... and it's switchable so you can use large speakers, if you wish.

Compact, but no compromises. You get "full-size" high-fidelity features with System Seven—magnetic and aux inputs, tape monitor, A/B speaker switching,

even 75 and 300-ohm FM inputs. U.L. listed, of course, and housed in a stunning jet-black metal cabinet with blackout dial.



Receiver is briefcase-sized, a little taller than a credit card—just 3-1/2" high. Each speaker is about the size of two average books.

The price for all this may be the surprise of your audio life—only \$239*, a savings of \$40.85 off the "each" price!

Audition System Seven. You'll want to dance all night!

*Price may vary at individual stores and dealers.

Sold only at

Radio Shack®
The nationwide supermarket of sound®

A Division of Tandy Corporation
Fort Worth, Texas 76102

WHOLESALE LOCKSMITH SUPPLIES



ORDER YOUR
GIANT
CATALOG

NATIONAL
LOCKSMITH
SUPPLY
N-79
CATALOG

NATIONAL LOCKSMITH SUPPLY P.O. BOX 31598 DALLAS, TEXAS 75231

jam packed with the latest in Locksmith Tools, Key Machines, Key Assortments, Deadbolts, Foreign Cal Key Blanks, complete line of Safes, Closed Circuit TV Systems, Alarm Systems, High Security Locks, Electronic Lock Card Systems, I.D. Cards, Technical Manuals, Code Machines, and much, much more! **National's Your One-Stop Locksmith Supply Supermarket!** Most orders shipped within 24 hours! We welcome locksmith, student locksmiths, and industrial accounts. To order, **National's catalog send \$5.00** (refundable after first purchase of \$25.00 or more). Your catalog will be rushed to you by first class mail!

BE A LOCKSMITH

\$49.95

COMPLETE
COURSE



Kit contains: LOCK PICKS, CAR OPENING TOOL, LOCKS, KEYS & KEYS
COURSE: COVERT LOCK PICKING, MASTER KEYING, KEY IMPRESSIONING, RE KEYING

Today, a trained Locksmith can just about
make his own living! Locksmiths average
\$15.00 an hour. Learn at home. Earn at home.
Fast pay. Course that trains you in
doing all keys, picks, picks, jacks and
special equipment supplied. Zooming
time is everywhere. Everyone is seeking
greater protection. Cash in at once. Train
at home. Earn extra \$15 right away. Send
for exciting facts and a Free Lesson. No
obligation or Send \$49.95 for complete kit
& \$1.75 shipping & handling. Texas resi-
dents add sales tax. C.O.D. accepted. 10
day money back guarantee.

NATIONAL LOCKSMITH SUPPLY CORP.
P.O. BOX 31598 DEPT.
DALLAS, TEXAS 75231
CIRCLE NO. 36 ON FREE INFORMATION CARD

CIRCLE NO. 36 ON FREE INFORMATION CARD

SEE YOUR DEALER TODAY

DEMAND THE ORIGINAL

'Firestik'

"THE FUEL-SEEKER"

THE #1 WIRE-WOUND AND MOST
COPIED ANTENNA IN THE WORLD!

Rugged, Shatterproof Fiberglass

CB Antennas and accessories for marine, RV,
truck, auto, van and motorcycles, etc.

Four Colors: Silver-Gray, Black, Red, and White

Our 17th Year Serving the CB & Communications Market

SEND FOR FREE CATALOG



LIMITED OFFER — USA ONLY

Get this nine-inch 'Firestik' Antenna Wars decal
in four beautiful colors on a PAL T-shirt.
See your dealer today or send \$3.00 to:

PAL 2614 East Adams/Phoenix, Az. 85034

Name

Street

City

State

Zip

Dealer & Distributor Inquiries Invited

5-YEAR REPLACEMENT WARRANTY

CIRCLE NO. 46 ON FREE INFORMATION CARD



Product Test Reports

McKay Dymek Model DR33C Communications Receiver



A digital frequency-synthesized tuning range from 50 kHz to 29.7 MHz is featured in McKay Dymek's Model DR33C professional-quality general-coverage communications receiver. This triple-conversion superhet is designed for maximum immunity to overload and intermodulation; it employs an r-f power transistor to minimize overload in the front end and highly selective filters in each i-f conversion circuit.

Tuned frequencies are displayed on a six-digit 0.5" (12.7-mm) numeric LED display that extends across approximately two-thirds of the front panel. Other features include switchable selectivity with provision for two additional optional filters; a bfo suitable for reception of AM, USB, LSB, CW, and RTTY; built-in speaker; and audio output jack and level control for driving an external amplifier.

Any 50-ohm antenna can be connected to the receiver. An optional Model DA100 active antenna, specially suited to the DR33C receiver (but usable with most other communications receivers) is available as an extra-cost option. It is designed to operate over the entire range of the receiver and features a 56" (1.4-meter) whip element whose weather-sealed mounting base contains a full-range feedback amplifier with high overload immunity.

The receiver measures 17.5"W x 15"D x 5.1"H (445 x 381 x 130 mm) and weighs 16 lb (7.3 kg). Price for the receiver is \$1500.

General Description. From left to right, the numbers in the display indicate frequency in tens of MHz, MHz, hundreds of kHz, tens of kHz, kHz, and tenths of kHz. Each decade in the display can be set individually via its own rotary switch. Tens of MHz can be set for only 0, 1, or 2. (Leading zeros are suppressed.) The tens-of-kHz switch has 20 steps of 5 kHz each, and each of the remaining switches has a 0-to-9 range.

The FINE TUNE control is a 10-turn potentiometer that can vary the tuning continuously to permit interpolation across the 5 kHz between switch settings. It affects the last two

display digits, which are driven by a frequency counter, displaying kHz and tenths of kHz.

A small meter is calibrated in arbitrary S units up to S9 and in 10-dB steps from 0 to 80 dB. The IF FILTER switch provides a choice of a 4- or 8-kHz AM filter, separate 2.2-kHz LSB or USB filter, or any two user-installed accessory filters such as the 400-Hz CW and 1200-Hz RTTY filters offered as options.

The BAND control actually selects input filtering and attenuation for the receiver. Two 0.05-29.7-MHz positions cover the entire tuning range. One position inserts and the other bypasses an r-f amplifier stage. Two 2.5-29.7-MHz positions insert a 2.5-MHz high-pass filter into the input circuit for high-frequency reception near a powerful broadcast station and offer either amplified or unamplified r-f operation. Finally, the LOCAL position reduces sensitivity by 30 dB.

Appropriate bfo and detector circuits for AM, CW, RTTY, and SSB reception are selected via the MODE switch. (The optional external converter and printer are required for RTTY operation.)

On the rear apron are phono-jack and parallel insulated binding-post antenna connectors; external-speaker binding posts and switch to disable the internal speaker; a normally shorted MUTE jack that silences the receiver when no signal is received; IF OUTPUT jack that provides access to the 455-kHz third i-f; TUNER OUTPUT jack and level control for driving an external amplifier; line fuse; and switch for selecting 117 or 220 volts ac.

The antenna input is protected by a 1/16-ampere fast-acting fuse. All incoming signals go through a 30-MHz low-pass filter to suppress image responses. After passing through the BAND switch system (and r-f amplifier, if required), the signal goes to a double-balanced mixer in which hot-carrier diodes are used to insure minimal intermodulation on very strong signals. The mixer combines the incoming signal and a signal from the synthesizer and delivers a 30-MHz first-i-f output. Phase-locked-loop (PLL) techniques are used to generate the first local-oscillator

frequencies in 5-kHz steps from 30.05 to 59.7 MHz. Accuracy is determined by a single 8.000-MHz crystal oscillator. Just after the first mixer is a two-pole crystal 30.000-MHz filter whose 30-kHz bandwidth minimizes IM distortion from overload in the first i-f amplifier and subsequent stages.

After amplification, the 30-MHz signal goes to a second balanced mixer driven from the second local oscillator at 40.7 MHz. The 40.7-MHz signal is derived by tripling the output of a 13.566-MHz crystal oscillator. The frequency of this oscillator can be "pulled" over a limited range by a voltage-variable capacitor operated by the FINE TUNING control. Before amplification, the 10.7-MHz second-i-f output from this mixer goes through an 8-kHz bandwidth four-pole crystal filter.

Applied to the inputs of the dual-gate MOS-FET third mixer are an 11.155-MHz signal from a crystal-controlled third local oscillator and the second-i-f signal. The 455-kHz third i-f at the output of this stage is channeled through one of several filters by dc voltages applied to FET switches. The 4- and 8-kHz filters, used primarily for AM reception, are ceramic types, while Collins 2.2-kHz-bandwidth mechanical filters are used for SSB. An envelope detector is used for AM, while an IC balanced modulator is used as a product detector for CW and SSB. Supplied by the logic board that controls the frequency synthesizer, the bfo signal to this detector is 455.0 kHz on SSB, 455.8 kHz on CW, and 457 kHz on RTTY.

Detected audio is passed through a 3-kHz low-pass filter and then a 5-kHz notch filter to remove carrier beats. (On the short wave broadcast bands, stations are often spaced only 5 kHz apart.) An IC audio amplifier delivers a 2-watt output.

Because the receiver performed with a degree of competence beyond that of our test instruments, the only quantitative measurements we made were of the response of the S meter. In the high-frequency range, a mere 0.5 μ V produced an S3 reading, 1.2 and 2 μ V producing readings of S6 and S9, respectively. On the decibel scale, 60 dB was indicated with an 8- μ V input, 70 dB with a 100- μ V input, and 80 dB with a 5000- μ V input. Sensitivity was down by a factor of about 5 to 6 at 28 MHz and 100 kHz.

Agc action was far slower than average. The meter, driven by the agc voltage, responded in about two seconds when a 60-dB input was applied. It required some seven seconds to decay to its zero index at S1 when the signal was removed. This was done, according to the manufacturer, to prevent noise pumping on SSB reception.

User Comment. Obviously, the DR33C is not meant to be sweep-tuned in the conventional manner. One need only set the display for a known frequency to have the desired station pop right up. Moreover, no practice or development of a "touch" is necessary to obtain accurate results. A user wishing to search for unknown stations must examine 5 kHz of bandwidth at a time using the FINE TUNE control. The method, though a little tedious because of the slow action of the control and the agc response, virtually ensures a thorough search. For practical tuning of AM stations, FINE TUNE can be ignored until the signal is heard.

Tuning of this receiver is best accom-

plished by ear, also because of the slow action of the meter. An additional effect of the long agc time constant is that the receiver does not always handle normal signal fading well. On the other hand, the noise limiter (switchable) was very effective against impulse noise, albeit at the cost of considerable distortion in the audio. In view of the price of this unit, however, we would have expected that a noise blanker would be included.

Though the advanced circuitry of the DR33C would enable it to cope well with the demands of Amateur Radio and other specialized applications, its frequency coverage and general design mark it as a deluxe general-coverage receiver. Little effort has been spared to offer a user a maximum of conven-

ience and accuracy in return for a minimum of skill. In particular, the synthesizer's accuracy and the stability of tuning can simplify the problem of identifying a station without a broadcast ID.

To sum up, the DR33C is one of the most advanced and versatile general-coverage communications receivers available to the consumer. In some respects it compares favorably with commercial and military receivers selling for several times its price. We suspect that an enthusiastic, well-heeled neophyte to short-wave listening who wants to spend time enjoying his hobby rather than "paying dues" will find this receiver much to his liking.

CIRCLE NO. 105 ON FREE INFORMATION CARD



The DMM you've wanted: Quality and performance at a low, low cost

A surprisingly low \$69.95. Surprising because you get the type of performance you've wanted but expected to pay much more for.

Quality, Performance and Accuracy

The 2010A offers you long-term accuracy with a laser-trimmed resistor network, a stable bandgap reference element, and single-chip LSI circuitry. With 31 ranges and 6 functions, you can measure AC or DC volts from 100 μ V to 1000V; AC and DC current from 0.1 μ A to the way to 10 A; resistance from 0.1 Ω to 20 M Ω . Typical DCV and Ohms accuracy is 0.1% \pm 1 digit. Easy-to-read 3½ digit LED's with 9mm numerals and automatic decimal point.

Extra features for greater convenience and flexibility

- Unique X10 multiplier switch gives you convenient selection of the next higher decade. Hi-Low Power Ohms capability gives you three high-ohm ranges that supply enough voltage to turn on a semiconductor junction. You use the three low-ohm ranges for in-circuit resistance measurements.
- Wide Frequency Response: 40 Hz to 40 kHz bandwidth lets you measure audio through ultrasonic AC signals.
- Touch-and-Hold Capability (with optional probe) lets you hold readings as long as you wish so you can make measurements in hard-to-reach places without taking your eyes off the probe tip.

- And More: automatic polarity and zeroing; overrange indication; overload protection on all ranges.

This compact unit is powered by 4 "C" cells (not included) so that you can take your lab-quality benchtop unit anywhere with you.

Kit or Factory-Assembled

Either is a tremendous value. Complete kit only \$69.95; assemble it yourself with our easy-to-follow instructions. Or, for only \$99.50, Sabtronics will ship your 2010A factory-assembled and calibrated.

Whether you're a professional or a hobbyist (or both!): When quality, accuracy, and price count, you should check out the 2010A DMM for yourself. Order one today for a full 10 days to inspect it; if you're not completely satisfied, merely return it in its original condition for a prompt and courteous refund of purchase price. Call with your Master Charge or Visa number or write the address below.

2010A Kit: \$69.95 (plus \$4.00 S&H)

2010A Assembled: \$99.50 (plus \$4.00 S&H)

AC-115 Adaptor: \$7.50

NB-120 Nickel Cadmium Batteries: \$17.00

THP-20 Touch and Hold Probe: \$18.00

PRICES GOOD THROUGH OCT. 30, 1979
Making Performance Affordable

sabtronics 
INTERNATIONAL INC.

13426 Floyd Circle M/S 24 Dallas, Texas 75243
Telephone 214/783-0994



By John McVeigh, Technical Editor

LONG TIME DELAYS AND THE 555

Q. *I don't have a lot of experience in working with IC's, but I have been tinkering with 555 and 556 timers. I suspect that not all 555s are the same; perhaps 556s as well. I can achieve a long time delay with one (on the order of hours), but cannot with another. Can I expect reproducible delays if I get a 555 to time out after 8 hours or so? Also, do the suffixes stamped on the IC's (555V, 555N, etc.) mean anything? —Mark McWilliams, South Charleston, WV.*

A. Within given manufacturing tolerances (about 1%), all 555 timers should produce the same time delays when used in the monostable mode or the same frequency of oscillation is used as astable multivibrators. This means that if you assemble a circuit using an IC socket, Molex Soldercons, or a solderless breadboard, get it running and then replace only the timer IC, you should obtain almost identical results.

The problems you are experiencing can be traced to two factors, both of which are aggravated by the need for large amounts of timing capacitance in your long-delay circuits. The only practical way to get several hundred or thousand microfarads in a reasonably small volume is to use an electrolytic capacitor. The leakage resistance of an electrolytic is low as compared to that of other types of capacitors. In many circuits, this can be tolerated. But in timing circuits employing, say, 18-megohm resistors and 100- μ F capacitors, the leakage resistance will make its presence known! Also, most electrolytics have very large tolerances ($\pm 50\%$, $\pm 100\%$ is not unusual), and this variation in capacitance will have a direct influence on the behavior of the timer. That's why tantalum capacitors, with their tighter tolerances ($\pm 10\%$ or $\pm 20\%$), are preferred in timer circuits.

To obtain long delays with smaller capacitors, try experimenting with the Exar XR-2242CP programmable counter. This chip includes a 555 timer and an

eight-stage programmable counter and can generate really long delays—on the order of days—and can be cascaded with other 2242's to produce delays in years! It's available from several mail-order companies who advertise in the Electronics Market Place section.

Finally, the suffixes at the end of the IC number sometimes refer to package types or product grade. (Prefixes denote manufacturers.) For the 555, however, all manufacturers use the eight-pin mini-DIP and the suffix isn't really important.

SINE WAVE CONVERTER

Q. *Can you show me a circuit that will convert a ramp, sawtooth or square-wave output of a VCO into a sine wave? I have tried a few simple designs (resistor-diode networks), but have not had success. —N.W. Greene, Bellport, NY.*

A. A Fourier analysis of a ramp, sawtooth, square or any periodic waveform reveals that it comprises sine waves at a fundamental frequency and a certain number of harmonics, each at a specific amplitude. Therefore, a high-order, low-pass filter or a sharp bandpass filter will extract the fundamental sine wave from any of the waveforms you mentioned. A bandpass filter can also be used to extract a selected harmonic from the input signal. Because you are using a VCO, you should use a voltage-controlled filter (VCF). Apply a steady dc level to the control inputs of both the oscillator and the filter and observe the output of the VCF. Adjust the filter's control for the desired sinusoidal output. Then, if the same variable control voltage is applied to the filter and oscillator and if the two track each other properly, the VCF will continue to deliver a sine-wave input. This is so because the filter's cutoff or center frequency will change in step with

Have a problem or question in circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

the frequency of the ramp, sawtooth, or square-wave oscillator output.

SUBSTITUTING COMPONENTS

Q. *Can a 100-volt, 8-ampere SCR be substituted for a 100-volt, 6-ampere SCR in a 5-volt, 3-ampere power supply? —Alan Martello, Turtle Creek, PA.*

A. As a general rule, an overrated component can be used as a substitute in any electronic circuit. For example, a $\frac{1}{2}$ -watt carbon resistor can be used in place of a $\frac{1}{4}$ -watt carbon resistor, or a 100-volt, 0.1- μ F ceramic disc capacitor can be used in place of a 50-volt, 0.1- μ F ceramic disc. In the case of active components, the same holds true as long as the substitute has comparable device parameters. So, a transistor with a maximum I_C of 800 mA can be used to replace one with a maximum of 400 mA if it has comparable current gain (β), f_T , $V_{CE\text{ max}}$, power dissipation, etc.

The only potential trap for the unwary is an overrated substitute with, say, a lower β or, in the case of an SCR gate sensitivity. The higher-current SCR might require more gate current to turn it on. In most situations, however, either there will be sufficient gate current or the gate resistor can be decreased to compensate. In your power supply, the SCR is probably part of the protective circuit and a direct replacement can be made.

DIGITAL READOUT FOR SWLS

Q. *I have just purchased a Realistic DX-160 shortwave receiver and would like to augment the dial with a digital frequency readout. Do you have a circuit for one? —Rory Sena.*

A. In the February 1977 issue of POPULAR ELECTRONICS, an article entitled "Digital Frequency Readout for Shortwave Receivers" appeared. The project is essentially a frequency counter which could be preloaded with a number to compensate for the i-f of the receiver. This is done because the most easily sampled signal, the output of the local oscillator, is displaced from the frequency of the incoming signal by an amount equal to the i-f. The project was offered in kit form by Mattis Electronics, Box 162, Morton Grove, IL 60053. I suggest that you obtain a back issue to look at the circuit or, if you want to build the kit, write to the company to learn if it is still available, current prices, etc.



Tips & Techniques

CLEANING PC BOARDS

The next time you have to clean a printed circuit board, try a scouring pad marketed under the trade name Scotch-Brite. These green, nonmetallic pads can clean boards (or pots and pans) as effectively as steel wool, but don't rust or splinter, and are kinder to your hands. In fact, one well-known company includes in its pc etching kit a small pad for cleaning boards which closely resembles the product suggested here. —*Gane Wong, Vancouver, B.C.*

AMMONIA AND SOLDERING TIPS

It's wise to remove the threaded tip from your pencil iron periodically to prevent oxidizing. Otherwise, the tip will become so tightly bonded to the pencil that removal will be a tedious job. In severe cases, you will not be able to remove the tip without damaging the iron. In cases where this removal chore has been neglected, the tip can be extracted quickly and without damage to the iron by spraying a bit of household ammonia on the copper tip and the threaded recess of the pencil. When reinstalling the tip, first dab some powdered graphite into the recess. This will make tip removal easier the next time. —*Harry J. Miller, Sarasota, FL.*

TEMPLATE SIMPLIFIES SLIDE SWITCH MOUNTING

Slide switches which require rectangular panel slots can be easily mounted if the following procedure is followed. First, remove the metallic shell enclosing the switch by bending up the four retaining tabs. Using the shell as a template, scribe and drill the holes for the retaining screws. Now, using the shell as a jig, mount it on the panel. Then drill out and file the rectangular slot, letting the file bear heavily on the panel but *lightly* on the jig. File until the panel slot is evenly matched with the jig. Finally, remove the shell, reassemble the switch and mount it on the panel. Better yet, mount a *new* switch and save the shell-jig for making slots in the future. —*Clem Portman, San Clemente, CA.*

IDENTIFYING COMPONENTS

When sorting electronic components, especially those with strange markings in a grab-bag assortment, a method of labeling devices is necessary. An easy way to permanently label components is to use self-adhesive color-coding dots. They come in sizes small enough to fit the tiniest of components that the experimenter is likely to procure. Also, they can be written on to denote exact values. The dots are available in a wide variety of colors for group coding, and are available at most stationery and business supply stores. —*Radcliffe Cui-shaw, Knoxville, TN.*

LOW VOLTAGE INDICATOR

This circuit can be used as a low-voltage battery condition indicator. The LED will glow when $V+$ drops below a certain value. Current drawn when $V+$ is above the threshold is only 100 μA at 20 volts. All parts are easily obtained at a total cost of about \$2. The circuit will function over a range from 1.6 to 30 volts.

Here's how the circuit works. Potentiometer $R3$ adjusts the base bias of $Q1$, which in turn determines the voltage drop across $R1$. Capacitor $C1$ and $R1$ act as an RC network to allow $Q1$ to settle when new batteries are installed. The voltage developed across $R1$ determines the gate drive for $SCR1$. When $SCR1$ fires, the LED glows and continues to do so until new batteries are installed. Resistor $R2$ can be changed to vary LED brightness. The voltage threshold is determined by the setting of $R3$. You will find that the potentiometer adjustment is insensitive. A 50,000-ohm potentiometer can be substituted for greater adjustment sensitivity. This will increase current by approximately 300 microamperes. —*S. Lay, Huntington Beach, CA.*

UNSOLDER SAFELY

Unsoldering and removing multi-pin components (especially IC's) presents a real problem. Here's a simple and safe way to do it. Dip one end of a scrap length of braided shielding into rosin soldering paste and apply it to the connection(s) to be unsoldered. Then place a hot soldering iron on the braid. Solder will be drawn into the braid by capillary action. Remove the component, and then the iron and braid. Clean the area with denatured alcohol before soldering the new component. The end of the braid should be cut off when it is saturated with solder, of course. —*Victor Mungary, Bakersfield, CA.*

McIntosh

"A Technological Masterpiece..."



McIntosh C 32

"More Than a Preamplifier"

McIntosh has received peerless acclaim from prominent product testing laboratories and outstanding international recognition! You can learn why the "more than a preamplifier" C 32 has been selected for these unique honors.

Send us your name and address and we'll send you the complete product reviews and data on all McIntosh products, copies of the international awards, and a North American FM directory. You will understand why McIntosh product research and development always has the appearance and technological look to the future.

Keep up to date.
Send now - - -

McIntosh Laboratory Inc.
Box 96 East Side Station
Binghamton, NY 13904

Name

Address

City State Zip

If you are in a hurry for your catalog please send the coupon to McIntosh. For non-rush service send the Reader Service Card to the magazine.

CIRCLE NO. 33 ON FREE INFORMATION CARD



Solid State

By Lou Garner

DOWN NOSTALGIA LANE

LOOKING back over the past quarter-century, one soon realizes that POPULAR ELECTRONICS and the solid-state industry have grown to maturity together. When the first issue of the magazine appeared in October 1954, the transistor itself was a mere infant scarcely over six years old, having been introduced publicly by the *Bell Telephone Laboratories* in June 1948. This was the early—and now obsolete—point-contact transistor. The junction transistor, still a viable type, was even younger, for it was not introduced by *Bell* until July 1951. It was less than two years earlier, late 1952, that transistors had made their first appearance in consumer products—expensive hearing aids.

In those days, the vacuum tube was the king, and that first issue, Volume 1, Number 1, featured but a single "solid-state" construction project—an AM Broadcast Band crystal receiver using the ubiquitous 1N34 germanium diode. There were, however, descriptions of several solid-state products, including a battery-eliminator charger kit using selenium rectifiers and a transistor experimenter's kit. In addition—shades of the current energy crunch—there was a feature story on solar batteries! The next two issues, November and December 1954, featured no further solid-state projects since the devices were not yet modestly priced.

There was good news for the experimenter in late 1954, however, for the *Raytheon Manufacturing Company* had cut the price of its fantastic experimenter's transistor, the CK722, to a mere \$3.50, bringing it well within the reach of virtually every hobbyist. Introduced in early 1953, the CK722 was actually a selected "fall out" from the firm's premium-priced hearing-aid transistor line. A low-voltage, moderate-gain, low-power, audio-range, germanium pnp junction transistor assembled in a plastic case, the unit originally was priced at \$7.60 each—not a bad price at the time, considering that other available transistors were \$50.00 each and up! And those were "middle 50's" dollars, which had a lot more purchasing power than today's inflated dollars. POPULAR ELECTRONICS carried a newsstand price of only twenty-five cents, and a 12-ounce *Pepsi-Cola* cost only a nickel, as did candy bars, packs of chewing gum, and two-ounce packages of potato chips. You can bet that experimenters and hobbyists were very, very careful with how they handled their transistors then!

Although the vacuum tube continued its dominance, transistor prices began to drop slowly with each passing month. More semiconductor manufacturers entered the field, increasing competition. New devices were introduced. Solid-state electronic projects appeared a little more often in these pages and experimenter interest waxed hotter and hotter. Before long, the editors decided that the young upstart, the transistor, needed special treatment. Consequently, they started a regular column entitled "Transistor Topics." A Contributing Editor since the magazine's first issue, I was asked to take over that column soon after it first appeared. By the time my first column was published in June 1956, the transistor was starting to come into its own as a viable experimenter's device. Raytheon was offering an *n-f* transistor, the CK768, at a mere \$1.50, while the CK722 had broken the dollar barrier and was selling for only 99 cents.

Despite dropping prices, however, transistors were still considerably more expensive than vacuum tubes by mid-1956 so most construction projects used only one or, at a maximum, four transistors. A four-transistor broadcast-band receiver was featured in the May issue, a couple of single-transistor Geiger counters in June, and a single-transistor power megaphone in July. The latter was one of the first hobbyist projects to use a multiwatt power transistor, the 2N68.

From this point, Time and Progress marched forward arm in arm. Prices continued to drop. Hundreds of new transistor types were introduced. Interesting new semiconductor devices made the scene—the silicon controlled rectifier (SCR), the unijunction transistor, the

tunnel diode, the 4-layer silicon switch, the Gunn diode, the phototransistor, the triac, the Diac, the field-effect transistor (FET), charge-coupled devices (CCDs), the Darlington transistor, VMOS devices, integrated circuits, light emitting diodes (LEDs), and that fabulous "computer on a pinhead," the microprocessor. The trickle of semiconductor devices became a flood and, all the while, POPULAR ELECTRONICS and its readers kept pace. The vacuum tube was driven from its throne by the semiconductor legions, and "Transistor Topics" became "Solid State."

You've Come A Long Way, Baby! From the very beginning, POPULAR ELECTRONICS readers have been more sophisticated than most other electronics enthusiasts, enjoying advanced as well as elementary projects. Over the years, they have assembled not only a wide variety of conventional audio amplifiers and radio receivers and transmitters, but laser systems, electronic musical instruments, ultrasonic gear, test equipment, household and automotive alarms, light-beam communicators, calculators, electronic games, and minicomputers and peripherals.

"Reader's Circuits" was introduced originally as part of my first "Transistor Topics" column and later became a regular feature, continuing when the name was changed to "Solid State." Through this section, readers are able to share their pet designs with other experimenters and hobbyists. Early contributions tended to be relatively simple one- to three-device designs, and this trend has continued to the present. But while the specified devices in the early designs generally were single transistors and diodes, later designs often include one or more IC's (integrated circuits), each of which may contain the equivalent of from a half dozen to a hundred or more transistors.

Two early Reader's Circuits, from the June and July 1956 column, are shown in Fig. 1A and 1B. In those days, there was still some question regarding the proper reference symbol for a transistor, so you'll note a "V" (for valve) reference designation in one circuit, and a "TR" in the other. Today, of course, "Q" is the standard letter symbol for a transistor.

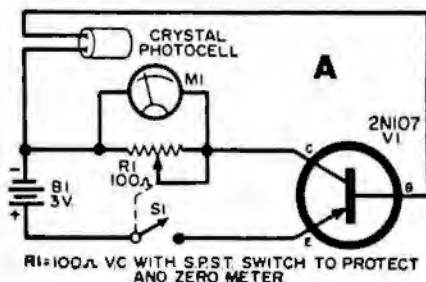


Fig. 1. Early reader circuits from PE June and July 1956: (A) light meter, (B) receiver.

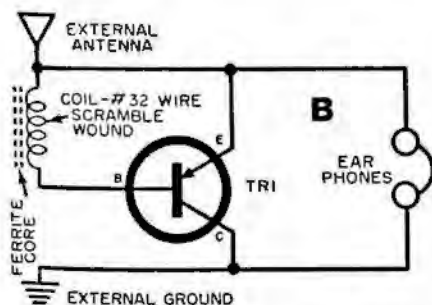


Fig 2. Circuit for a general-purpose alarm. Many applications are possible, depending on the sensor used.

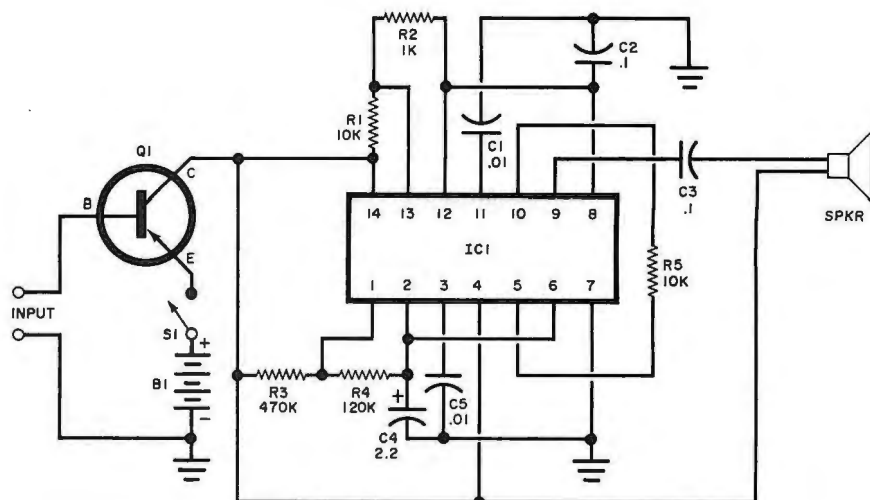


Figure 1A was submitted by Joe Gabus and features a Clairex type CL-1 cadmium-sulphide photocell direct-coupled to a GE type 2N107 pnp transistor, serving as a common-emitter dc amplifier. A 500-microampere meter, *M1*, is used as an output indicator, shunted by a 100-ohm potentiometer, *R1*, for calibration adjustment and meter protection.

The extremely simple receiver circuit contributed by Matthew Mandl, can use virtually any type of pnp or npn transistor. Designed for single-station reception, it uses a hand-wound coil on a ferrite core. The number of turns is determined experimentally (by guess and by golly) for best reception of the strongest local station. Unless the user lives near a broadcast station, an external antenna and ground system are mandatory.

The Past Is Prologue. Many years ago, in the 1800's, an important official suggested that the Patent Office be abolished, for "there was nothing left to invent." But look at what's happened not only since then, but just in the last quarter century: pocket calculators, electronic watches, electronic language translators, home computers, and on and on!

Predicting future developments is a fun game and one which I, a science-fiction aficionado, really enjoy. Here, then, are my predictions for the next quarter century:

In energy:

- Development of low-cost photovoltaic cells, making solar-generated electric power competitive with conventional sources.
- Development of economical fuel cells for vehicular use, making the electric car feasible for long as well as short trips.
- Development of small-scale nuclear power plants suitable for individual buildings and larger vehicular (trucks/buses) applications.

In computers:

- Development of megabit memories (i.e., a billion bits per module).
- Development of full aural interactive computer systems which not only respond to voice commands but which can answer questions.
- Similarly, development of microcomputer controlled test instruments and systems which react to voice commands and provide an audible response.

- Development of full-capacity computer systems with flat-screen displays and hard-copy printouts no larger than a standard attache case.

In general electronics:

- Continued development of specialized large-scale integrated circuits, leading to equipment and instrument design using systems engineering techniques.
- Continued development of more advanced discrete devices despite the increasing use of IC's.
- Breakthrough in solid-state or liquid-crystal imaging devices, leading to flat, large-size TV screens and displays.
- Comparable breakthrough in solid-state transducers, including sound generators (i.e., loudspeakers), sensors, and prime movers.
- Full integration of solid-state and microwave technologies, leading to lower priced instruments and equipment.
- Similar integration of solid-state and fiber-optic technologies, with fiber-optic light-beam communications and data transmission systems becoming as common as today's hard-wired networks.

Reader's Circuit. With literally dozens of potential practical applications, the general-purpose control/alarm circuit in Fig. 2 was submitted by high school student, Edwin Goei (111 Tophill, San Antonio, TX 78209). Depending on the type of sensor switch used, the circuit may serve as a water-level, freezer-failure, fire, intrusion, theft, or power-failure alarm. It requires no standby power, assuring long battery life and, once activated, emits an attention-getting "beeping" sound. Easily assembled in one or two evenings and requiring no special construction skills, the design uses standard components.

Two sections of a 556 dual timer, *IC1*, are used as interlocked low- and high-frequency multivibrators to generate the required "beep" signal, which drives a loudspeaker directly through dc blocking capacitor *C3*. To achieve control and minimize the need for standby power, pnp transistor *Q1* is used to switch the dc power source, *B1*. With switch *S1* closed, the circuit is inactive as long as the input terminals are open, for *Q1* is operating without base bias and thus behaves as a

(Continued on page 92)

THE BIG PLUS + Graphic Equalizer

ASSEMBLED
\$189⁹⁵

KIT
\$99⁹⁵



LOADED with Quality Features!

- Stereo . . . Eleven Bands Per Channel • Extremely Low Noise & Distortion • LED Peak Indicators • Center Detent ("flat") sliders • Built-in "record" Switching • Line and Microphone Level Inputs/Outputs • Regulated Power Supply • Fully Guaranteed • Horizontal or Vertical Cabinets • Kit or Fully Assembled • Plus Much, Much More!

Absolutely equals or exceeds overall performance and features of any graphic equalizer made today!

AARON-GAVIN INSTRUMENTS, INC. 714-957-8710

17231 Corla Avenue Tustin, California 92680

Yes! I've enclosed \$_____; RUSH me: ☐ assembled equalizers at \$189.95, p.p.d. ☐ cabinet ☐ send brochure ☐ Rack Mount
☐ unassembled equalizer kits at \$99.95, p.p.d. ☐ Horizontal (flat) ☐ Vertical (up-right)
 California residents include 6% sales tax Visa & Master Charge orders accepted

Name _____ Card No. _____
 Address _____ Exp. _____ Bank _____
 City _____ State _____ Zip _____ Date _____ No. _____

Dealer inquiries invited
 CIRCLE NO. 6 ON FREE INFORMATION CARD

Hobbyist or Professional, you get COMPUTER PROFESSIONALS' BOOK CLUB.



MINICOMPUTER SYSTEMS, Organization, Programming, and Applications. By Richard H. Eckhouse, Jr. and L. Robert Morris. 2nd Ed., 491 pp., illus. Updated, revised, and expanded, this is a book for every systems programmer, systems designer, computer scientist, and application specialist who wants to know more about microcomputer hardware, software, and design. 787/026 Pub Pr., \$21.95 Club Pr., \$17.75

MICROELECTRONICS: Digital and Analog Circuits and Systems. By Jacob Millman. 801 pp., 700 illus. Exciting news for the thousands of engineers who want a thorough refresher and updating on today's ICs. Will be welcomed by both digital and analog electronics engineers at every level of proficiency. 423/27X Pub Pr., \$24.50 Club Pr., \$19.50

AUTOMATIC DATA PROCESSING HANDBOOK. Edited by The Diebold Group. 976 pp., 269 illus. Written by a staff of internationally recognized authorities on ADP, this comprehensive handbook explains systems, programming and the languages, communications processes, and the design and installation of today's computers. 168/075 Pub Pr., \$38.95 Club Pr., \$25.75

THE Z-80 MICROCOMPUTER HANDBOOK. By William Barden, Jr. 304 pp., illus., paperbound. This book gives you the entire "state of the art" in microcomputer technology today. Arranged in three convenient and logically developed sections, the book discusses architecture and interface signals, then powerful interrupt sequences of Z-80 and interfacing examples of I/O memory devices. 784/914 Pub Pr., \$8.95 Club Pr., \$7.60



BE SURE TO CONSIDER THESE IMPORTANT TITLES AS WELL—

APPLYING MICROPROCESSORS, New Hardware, Software, and Applications. Edited by L. Altman & S. E. Scrupski. 191/603 Pub. Pr., \$19.50 Club Pr., \$15.50

57 PRACTICAL PROGRAMS & GAMES IN BASIC. By K. Tracton. 784/957 Pub. Pr., \$10.95 Club Pr., \$9.30

MICROPROCESSOR ARCHITECTURE AND PROGRAMMING. By W. F. Leahy. 784/612 Pub. Pr., \$19.95 Club Pr., \$14.95

MICROPROCESSOR AND MICROCOMPUTER SYSTEMS. By G. V. Rao. 783/659 Pub. Pr., \$24.50 Club Pr., \$19.50

THE BASIC COOKBOOK. By K. Tracton. 786/615 Pub. Pr., \$7.95 Club Pr., \$6.75

MICROPROCESSOR PROGRAMMING FOR COMPUTER HOBBYISTS. by N. Graham. 783/56X Pub. Pr., \$12.95 Club Pr., \$10.95

ILLUSTRATED DICTIONARY OF MICRO-COMPUTER TERMINOLOGY. By M. Hordeski. 786/631 Pub. Pr., \$12.95 Club Pr., \$10.95

HOME COMPUTER PROGRAMS. By J. W. Trudell, Jr. & M. Landberg. 787/042 Pub. Pr., \$8.95 Club Pr., \$7.60

FUNDAMENTALS OF COMPUTER ALGORITHMS. by E. Horowitz & S. Sahni. 786/380 Pub. Pr., \$19.95 Club Pr., \$15.95

ELECTRONICS DICTIONARY. By J. Markus. 404/313 Pub. Pr., \$24.50 Club Pr., \$19.50

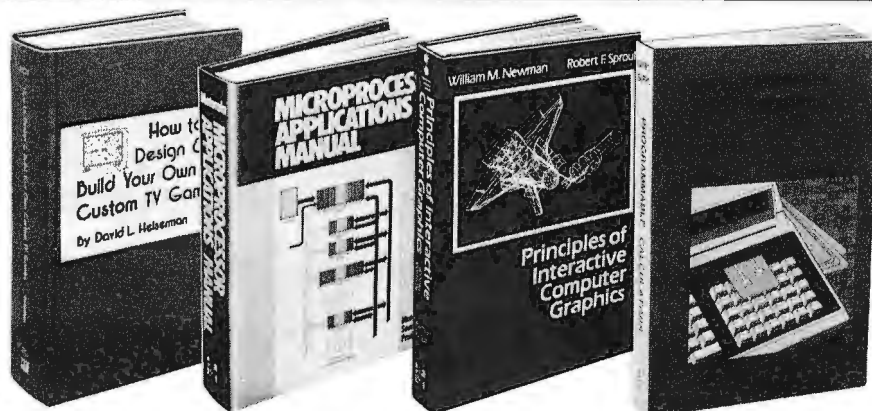
HANDBOOK OF OPERATIONAL AMPLIFIER CIRCUIT DESIGN. By D. F. Stout; edited by M. Kaufman. 434 pp., 223 illus. Compact, concise, and highly concentrated, this unique "one-stop" designer's handbook contains an enormous amount of information. 617/97X Pub. Pr., \$29.65 Club Pr., \$17.50

PRINTED CIRCUITS HANDBOOK. Edited by C. F. Coombs, Jr. 2nd Ed., 634 pp., 595 illus. Covering the subject of printed circuits from the design's idea to final acceptance, this enormously well-received work includes double-sided plated boards through printed boards and also the major variations such as multilayer and flexible circuits. 126/089 Pub. Pr., \$32.50 Club Pr., \$24.50

PRINCIPLES OF INTERACTIVE COMPUTER GRAPHICS. By William M. Newman and Robert Sproull. 2nd Ed., 544 pp., illus. Now in a revised, updated Second Edition, this is a volume that has long been THE standard source of information for designers! 463/387 Pub. Pr., \$19.95 Club Pr., \$14.95

PROGRAMMABLE CALCULATORS. By Charles J. Sippl and Roger J. Sippl. 526 pp., illus, 6 1/2 x 10 format, paperbound. Profusely illustrated, this book analyzes pocket "programmable" calculators. The authors concentrate on the trade-up models that users will soon be purchasing. 784/493 Pub. Pr., \$13.95 Club Pr., \$11.50

THE 8080A BUGBOOK: Microcomputer Interfacing and Programming. By Peter R. Rony, David G. Larsen, and Jonathan A. Titus. 416 pp., with figures, charts, and tables, paperbound. Gives you the basic concepts of microcomputer interfacing and the associated microcomputer I/O programming to develop your own interfaces. For the 8080 user, this book will be invaluable. 783/845 Pub. Pr., \$9.95 Club Pr., \$8.45



Computer Professionals' Book Club

MEMBERSHIP ORDER CARD

Enroll me as a member and send me the three books indicated. I am to receive the premium books at the introductory price of \$2.95 plus my first selection at the discounted price to members, plus tax, postage and handling. If not satisfied, I may return the books within 10 days and request that my membership be canceled. If I keep the books, I agree to take a minimum of three additional books during the next two years. I will receive the Club Bulletin 13 times a year. If I want to examine a featured selection, I need take no action. It will be shipped automatically. If I want an alternate selection—or no book at all—I notify the Club by returning the card enclosed. A postage and handling charge is added to each shipment. I will have a minimum 10 days in which to return the card, and you will credit my account fully, including postage, if this is not the case. Membership in the club is continuous but cancellable by me at any time after the four book purchase requirement has been fulfilled. *This order subject to acceptance by McGraw-Hill. Orders from outside the U.S. must be prepaid with international money orders in U.S. dollars. Tax exemption status is not applicable to purchases made through individual Club memberships.*

INDICATE BY NUMBER THE THREE BOOKS YOU WANT

Write Code # of
1st Premium Book Here

Write Code # of
2nd Premium Book Here

Write Code # of
First Selection Here

SEND NO MONEY. SIMPLY MAIL THIS CARD TODAY AND WE WILL BILL YOU.

Charge my ☐ VISA ☐ MASTER CHARGE* Exp. Date _____

Credit Card # _____ *MC Bank # _____

Signature _____

Name _____

Address _____

City _____ State _____ Zip _____

EXTRA SAVINGS: Remit in full with your order, plus any local and state tax and McGraw-Hill will pay postage and handling charges. (Applicable to U.S. orders only).

Popular Electronics 1979

P39407

Computer Professionals' Book Club

MEMBERSHIP ORDER CARD

Enroll me as a member and send me the three books indicated. I am to receive the premium books at the introductory price of \$2.95 plus my first selection at the discounted price to members, plus tax, postage and handling. If not satisfied, I may return the books within 10 days and request that my membership be canceled. If I keep the books, I agree to take a minimum of three additional books during the next two years. I will receive the Club Bulletin 13 times a year. If I want to examine a featured selection, I need take no action. It will be shipped automatically. If I want an alternate selection—or no book at all—I notify the Club by returning the card enclosed. A postage and handling charge is added to each shipment. I will have a minimum 10 days in which to return the card, and you will credit my account fully, including postage, if this is not the case. Membership in the club is continuous but cancellable by me at any time after the four book purchase requirement has been fulfilled. *This order subject to acceptance by McGraw-Hill. Orders from outside the U.S. must be prepaid with international money orders in U.S. dollars. Tax exemption status is not applicable to purchases made through individual Club memberships.*

INDICATE BY NUMBER THE THREE BOOKS YOU WANT

Write Code # of
1st Premium Book Here

Write Code # of
2nd Premium Book Here

Write Code # of
First Selection Here

SEND NO MONEY. SIMPLY MAIL THIS CARD TODAY AND WE WILL BILL YOU.

Charge my ☐ VISA ☐ MASTER CHARGE* Exp. Date _____

Credit Card # _____ *MC Bank # _____

Signature _____

Name _____

Address _____

City _____ State _____ Zip _____

EXTRA SAVINGS: Remit in full with your order, plus any local and state tax and McGraw-Hill will pay postage and handling charges. (Applicable to U.S. orders only).

Popular Electronics 1979

P39408



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 42 HIGHTSTOWN, N.J. 08520

POSTAGE WILL BE PAID BY ADDRESSEE

**Computer Professionals'
Book Club**

P.O. Box 582
Hightstown, New Jersey 08520



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 42 HIGHTSTOWN, N.J. 08520

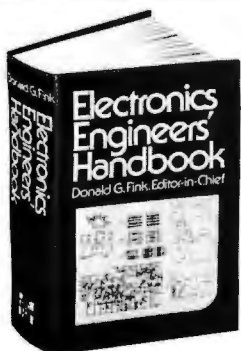
POSTAGE WILL BE PAID BY ADDRESSEE

**Computer Professionals'
Book Club**

P.O. Box 582
Hightstown, New Jersey 08520



the best books in the field from the Great Savings Too! (values up to \$76.95)



This title
counts
for two
premium
books

ELECTRONICS ENGINEERS' HANDBOOK. Editor in Chief, D. G. Fink. 2,104 pp., 2026 illus. Brings together in one instant-reference volume the essential principles, data, and design information known today on the components, circuits, equipment, and systems of all the various specialties that make up modern electronics.
209/804 Pub Pr., \$52.50 Club Pr., \$37.50

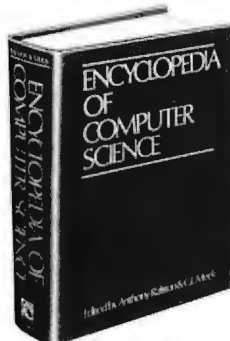
HOW TO DESIGN AND BUILD YOUR OWN CUSTOM TV GAMES. By David L. Heiserman. 544 pp., illus. Shows you how to create and build TV games from scratch and modify the ones you already have.
786/585 Pub Pr., \$14.95 Club Pr., \$11.95

ELECTRONIC GAMES, Design, Programming and Troubleshooting. by W. H. Buchsbaum and R. Mauro. 335 pp., 338 illus. Information you need to design, program, and troubleshoot electronic games is right here in this widely popular hands-on guide.
087/210 Pub Pr., \$17.50 Club Pr., \$14.00

PROGRAMMING LANGUAGES. By Allen B. Tucker, Jr. 439 pp., illus. Gives you not only the principles of design but the applications of six major programming languages. Shows you their strengths and weaknesses in solving various representative "benchmark" problems.
654/158 Pub Pr., \$22.00 Club Pr., \$16.50

ANALOG SYSTEMS FOR MICROPROCESSORS AND MINICOMPUTERS. By Patrick H. Garrett. 248 pp., illus. Explores all possibilities for analog systems in one applications oriented volume—with many specific examples.
786/496 Pub Pr., \$18.95 Club Pr., \$14.95

MICROCOMPUTERS/MICROPROCESSORS Hardware, Software, and Applications. By John L. Hilburn and Paul N. Julich. 372 pp., illus. Expressly created for people involved in the design, use, or maintenance of digital systems using microcomputers. The authors describe the theory and workings behind microprocessor architecture, read-only memory (ROM), random-access memory (RAM), and input/output interfacing methods.
771/449 Pub Pr., \$22.50 Club Pr., \$16.50



This title
counts
for two
premium
books

ENCYCLOPEDIA OF COMPUTER SCIENCE. Edited by Anthony Ralston and C. L. Meek. 1,500 pp., 60 illus., 100 charts, 7 x 10 format. This first and only in-depth coverage of the entire field of computer science in a single volume is comprehensive and completely up to date.
769/01X Pub Pr., \$60.00 Club Pr., \$39.95

LOGIC DESIGNER'S MANUAL. By John D. Lenk. 504 pp., illus. Written for logic IC users rather than for designers of logic ICs, this book uses time-tested existing commercial logic ICs to solve all design and application problems.
784/671 Pub Pr., \$18.95 Club Pr., \$15.75

MICROPROCESSOR APPLICATIONS MANUAL. By Motorola Semiconductor Products, Inc. 720 pp., illus., 8 1/2 x 11 format. With nuts-and-bolts practicality, this manual by the Motorola people (who should know) gives you detailed applications information on microprocessors and assumes no prior knowledge on your part about MPUs.
435/278 Pub Pr., \$38.00 Club Pr., \$26.50

any two
of these great
professional books
for only
\$2⁹⁵
values up
to \$76.95

Two Special
premium books
come to you with
your first selection

— MAIL THIS COUPON TODAY —

COMPUTER PROFESSIONALS' BOOK CLUB
P.O. Box 582, Hightstown, New Jersey 08520

Please enroll me as a member and send me the two books indicated. I am to receive the **PREMIUM BOOK** at the introductory price of \$1.89 plus my first selection at the discounted price to members, plus tax, postage and handling. If not satisfied, I may return the books within 10 days and request that my membership be canceled. If I keep the books, I agree to take a minimum of three additional books during the next two years. I will receive the Club Bulletin 14 times a year. If I want to examine a featured selection, I need take no action. It will be shipped automatically. If I want an alternate selection—or no book at all—I notify the Club by returning the card enclosed. A postage and handling charge is added to each shipment. I will have a minimum 10 days in which to return the card, and you will credit my account fully, including postage, if this is not the case. Membership in the club is continuous but cancellable by me at any time after the four book purchase requirement has been fulfilled. This order subject to acceptance by McGraw-Hill.

Write Code # of 1st premium book selection here	Write Code # of 2nd premium book selection here	Write Code # of 1st book selection here.
<input type="text"/>	<input type="text"/>	<input type="text"/>

Charge my ☐ VISA ☐ MASTER CHARGE* Exp. Date _____

Credit Card # _____ *MC Bank # _____

Signature _____

Name _____

Address _____

City _____ State _____ Zip _____

Orders from outside the U.S. must be prepaid with international money orders in U.S. dollars. **P39406**

COMPUTER PROFESSIONALS' BOOK CLUB saves you both time and money!

Here is a book club designed to meet all of your professional as well as hobbyist needs by providing practical books about computers on a regular basis at below publisher prices. If you're missing out on important technical literature—if today's high cost of reading curbs the growth of your library—here's the solution to your problem.

The Computer Professionals' Book Club was organized for you, to provide an economical reading program that cannot fail to be of value. Administered by the McGraw-Hill Book Company, all books are chosen by qualified editors and consultants. Their understanding of the standards and values of the literature of interest to you guarantees the appropriateness of the selections. Books are selected from a wide range of publishers.

How the club operates: Fourteen times a year you receive free of charge The Computer Professionals' Book Club Bulletin. This announces and describes the Club's featured book as well as alternate selections available at special members' prices. If you want to examine the Club's feature, you do nothing. If you prefer one of the alternate selections—or if you want no book at all—you notify the Club by returning the card enclosed with each Bulletin.

As a Club member, you agree only to the purchase of four books (including your first selection) over a two-year period. Considering the many books published annually, there will surely be at least four you would want to own anyway. By joining the Club, you save both money and the trouble of searching for the best books.

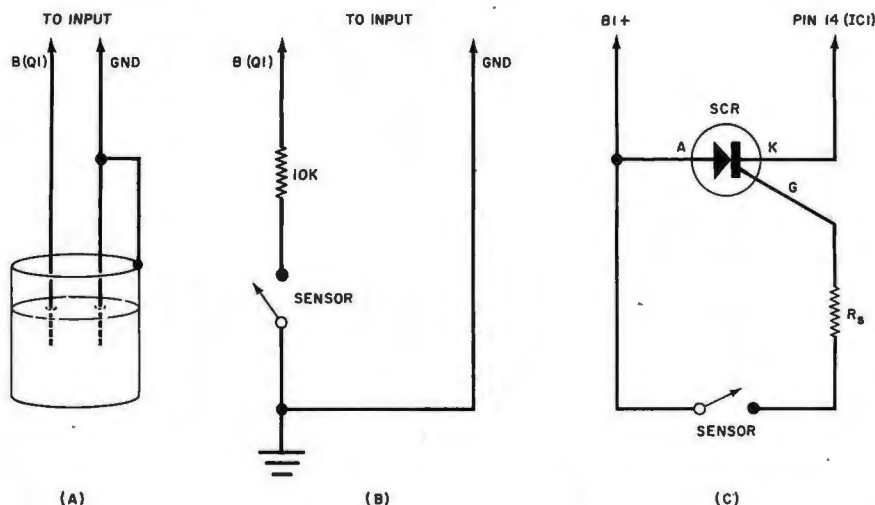


Fig. 3. Techniques for using reader's alarm circuit: (A) as water-level alarm; (B) with sensor and thermostatic switches; (C) in "latch-on" alarms.

high impedance or "open" circuit. If the input terminals are connected through a moderate resistance, base bias is applied to $Q1$, which shifts to a low-impedance state, thus supplying power to $IC1$ and activating the alarm.

Neither parts layout nor lead dress is critical and the circuit can be assembled using any construction technique. The power source, $B1$, is a standard 9-volt transistor battery, but six series-connected penlight or flashlight cells can be used instead. Switch $S1$ is a spst toggle, slide, rotary or pushbutton type, $Q1$ is a general-purpose npn transistor, and $IC1$, of course, is a type 555, although a pair of 555s can be used by making the necessary changes in pin connections. The resistors are all one-quarter or one-half watt types and the capacitors are conventional low voltage units.

Several techniques for using the basic design in different applications are suggested in Fig. 3. For a water tank or sump level alarm, simply mount two metal probes, such as heavy bus wire, rods, or tubes, so that they are contacted by the water at the level at which an alarm is to be sounded (Fig. 3A). The probes should be close together, but insulated from each other, with an exposed lower surface to make contact with the water. The probes are connected *directly* to the alarm's input terminals.

For applications using a simple switch sensor, such as a "Micro-switch" or bimetallic thermostatic switch, as in a freezer door or fire alarm, a 10,000-ohm, half-watt resistor should be connected in series with the "hot" input lead to limit the transistor's base current (Fig. 3B).

Finally, for burglar, theft, intrusion or similar applications requiring a continuously sounding alarm once tripped (until deliberately reset, of course), transistor $Q1$ should be replaced with a low-voltage sensitive-gate SCR, as shown in Fig. 3C. Depending on the installation, the sensor switch might be a normally open magnetic door switch, a pressure sensitive mat switch, a "Microswitch," or some similar device. The value of the series gate resistor, R_s , will depend on characteristics of the SCR used in the circuit. In operation, the alarm will sound continuously once the sensor switch is closed, even momentarily, until the system is "reset" by opening and closing the main power switch ($S1$, Fig. 2).

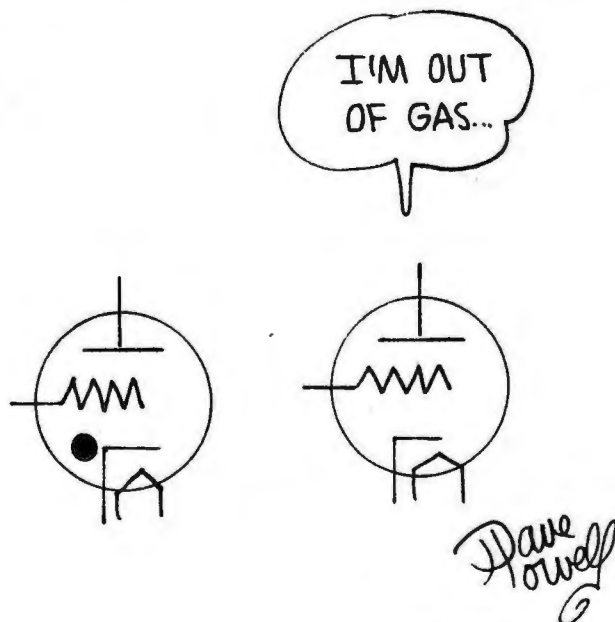
Device/Product News. Back when POPULAR ELECTRONICS—and the solid-state industry—were still infants, the word *hybrid* was used to describe electronic equipment, principally audio amplifiers and radio receivers, which used both transistors and vacuum tubes. A hybrid receiver generally used vacuum tubes in the r-f and i-f stages and transistors in the audio section. In hybrid audio amplifiers, transistors were used in the low-level voltage amplifier stages and vacuum tubes as power output amplifiers.

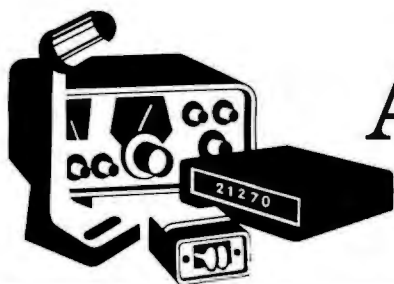
Today, hybrid is used to describe integrated solid-state circuits manufactured by assembling what are essentially discrete components, including resistors and capacitors, on a single substrate. The MWA Series of wideband r-f amplifiers are good examples of modern hybrid circuit design. Introduced recently by Motorola Semiconductor Products, Inc. (Box 20912, Phoenix, AZ 85036), these are single-stage amplifiers suitable for applications in r-f, i-f, agc, and isolation circuits as well as in-line drivers. With 50-ohm input and output impedances, the devices offer typical gains up to 14 dB and, depend-

ing on type, frequency responses from 100 kHz to 1 GHz. Thin-film hybrid construction on an alumina substrate is used with gold metallization and laser-trimmed nichrome resistors. The units are supplied in metal TO-39 hermetically sealed packages.

In addition to the wideband r-f amplifiers, Motorola has introduced a number of new discrete devices with potential applications in hobbyist projects, including a line of fast-switching npn power transistors and a family of plastic packaged high-power triacs. Designated the MJ8500 Series, the new power transistors offer maximum $V_{CEO(sus)}$ ratings of 800 V and IC ratings as high as 10 A, depending on type. Suitable for use in switching-mode power supplies, inverters, converters, and similar applications, the new devices are packaged in special metal TO-3 cases. Comprising sixteen different types, the new triac family features a 25-A current rating, with a 250-A surge capability. Identified as the MAC223/223A Series, they are offered with voltage ratings from 100 V to 800 V, depending on type. The highest voltage types are capable of handling loads in excess of 10 kW. Designed for lighting, heating, and motor control applications, the units are supplied in special TO-220 plastic packages.

The International Rectifier Corporation (233 Kansas St., El Segundo, CA 90245) is marketing a line of high-power MOSFET's. With high input impedances, high gain, and switching speeds to over 200 kHz, the new devices are offered with V_{DS} ratings from 60 to 400 V at continuous I_D ratings from 4 to 16 A, depending on type. The devices, therefore, can handle power levels in excess of 1 kW. Potential applications include audio amplifiers, switching power supplies, motor controls, induction heating, and ultrasonic systems. ♦





Amateur Radio

By Karl T. Thurber, Jr., W8FX

THOSE GOLDEN OLDIES

ANYONE who has attended a hamfest or swap meet or perused the shelves of one of the larger amateur radio distributors (one that takes used ham gear in trade toward the purchase of new) knows there has been a lot of equipment produced over the years to fill the needs and wants of the amateur radio community.

Many amateurs like to "hit" every big hamfest within reasonable distance to attend the technical forums, chat with other hams, and look over the manufacturers' displays and booths to examine new, state-of-the-art goodies. More fascinating, however, to many (and easier on the budget) is to rummage through the flea-market areas of these hamfests, eyeing others' castoff gear, and examining the trade-in shelves of the local ham emporium. You will find familiar and unfamiliar

brand names, surplus salvage, and homebrew equipment of every description. Especially interesting is the equipment produced by famous and once-famous manufacturers, many of whom are no longer in existence or who have long since abandoned the ham trade. You may find names such as Hallicrafters, Hammarlund, Collins, Lafayette, National, Eico, Johnson, and B&W, that were familiar long before Yaesu, Kenwood, Icom, Ten-Tec and Dentron equipment appeared. And you just might come across some not-so-familiar names such as Hunter, SBE, Eldico, Lakeshore, Gonset, Central Electronics, Multi-Elmac, Squires-Sanders, Elenco, Stancor, Globe, Galaxy, and Morrow. If you're lucky, you may even find some almost-forgotten, dusty rigs made by such old favorites as Harvey-Wells, Lettine, Palco, Geloso, RME, Lysco, Cosmos, Pierson-Holt, and Bud Radio. Occasionally, you'll see some gear by Jelectro, Temco, Aquadyne, Knight-kit, and Black Widow. Do you recognize any of these classic names of the 50s and 60s?

What did the typical beginner use for equipment, circa 1954? Very likely, the Novice (who then had to earn his license by tak-

from his friend. The set was a 9-tube-plus-regulator-and-rectifier job that touted "pencil-thin" (500-cycle) selectivity and 2-microvolt sensitivity—not bad for a set of that era with only one r-f stage. Having a "double-conversion" superhet scheme, the S-76 eliminated the "image" problem exhibited by its cousin, the S-40, as well as other single-conversion receivers. The S-76's 5-position selectivity control helped to separate signals that lesser sets could not. A giant, 4" S-meter, calibrated in units to "80 dBs above S-9," graced the front panel. It was an all-wave receiver, meaning it covered all the hf bands (including the standard broadcast band) to 34 MHz in four ranges, and it had a separate electrical bandspread tuning knob with calibrated dial to fine-tune the ham bands, which were crowded even then. Calibration accuracy, frequency stability, and sensitivity on the higher bands of most moderately priced sets such as this left a lot to be desired, however.

Building Your Own. Most amateurs bought ready-made receivers, not because they were afraid to build them, but because of the alignment problems once they were built. Many hams did build their own gear, however, especially transmitters, though most Novices compromised and built a kit. After all, how could one go wrong with Heath or Knight-kit instructions?

Very likely, our rank beginner tested his skills on one of the Heath Company's early



Collins 75A-4 receivers adorned many first-class amateur stations a decade or so ago. This set sold for about \$600 when new.



Typical Novice station of the early 60s featuring a Heath transmitter built from a kit.

The Hammarlund "Super Pro" SP-600 was one of the best of the old-line receivers. This set, when new, was over \$1000 but was going for \$195 at a recent hamfest.



ing both code and written exams in person before an FCC examiner) may have acquired a slightly used but sturdy Hallicrafters S-76 receiver from a newly-upgraded General who went on to purchase one of the "all new" Hallicrafters models for that year. The S-76 that our beginner purchased cost under \$200 when new, and perhaps two-thirds of that

ham-kit designs. The Heath AT-1 CW transmitter kit, probably filled the bill. It was a single-knob band-switching rig (no old-fashioned plug-in coils in 1954, please!) that covered the 80-, 40-, 20-, 15-, 11-, and 10-meter bands (eleven was a ham band then). The compact little set had a power input of 25-30 watts, well under the Novice maximum of 75



Write and run programs—the very first night—even if you've never used a computer before!

You're up and running with video graphics for just \$99.95 — then use low cost add-ons to create your own personal system that rivals home computers sold for 5-times ELF II's low price!

Featuring
RCA 1802 COSMAC CPU

Own a powerful home computer system, starting for just \$99.95—a price that gets you up and running the very first night... with your own TV for a video display, \$99.95 ELF II includes RCA 1802 8-bit microprocessor addressable to 64k bytes with DMA, interrupt, 16 registers, ALU, 256 byte RAM, full hex keyboard, two digit hex output display, stable crystal clock for timing purposes, RCA 1801 video IC to display your programs on any video monitor or TV screen and 5-slot plug-in expansion bus (less connectors) to expand ELF II into a giant!

ELF II Explodes Into A Giant!

Master ELF II's \$99.95 capabilities, then expand with GIANT BOARD... KLUGE BOARD... 4k RAM BOARDS... TINY BASIC... ASCII KEYBOARD... LIGHT PEN... ELF-BUG MONITOR... COLOR GRAPHICS & MUSIC SYSTEM... TEXT EDITOR... ASSEMBLER... DISASSEMBLER... VIDEO DISPLAY BOARD... and, another great reason for getting your ELF now—

BREAKTHROUGH!

Netronics proudly announced the release of the first 1802 FULL BASIC, written by L. Sandlin, with a hardware floating point RPN math package (requires 8k RAM plus ASCII and video display boards), \$79.95 plus \$2 p&h. Also available for RCA VIP and other 1802 systems (send for details)!

Master This Computer In A Flash!

Regardless of how minimal your computer background is now, you can learn to program an ELF II in almost no time at all. Our *Short Course On Microprocessor & Computer Programming*—written in non-technical language—guides you through each of the RCA COSMAC 1802's capabilities, so you'll understand everything ELF II can do... and how to get ELF II to do it! Don't worry if you've been stumped by computer books before. The *Short Course* represents a major advance in literary clarity in the computer field. You don't have to be a computer engineer in order to understand it. Keyed to ELF II, it's loaded with "hands on" illustrations. When you're finished with the *Short Course*, neither ELF II nor the RCA 1802 will hold any mysteries for you.

In fact, not only will you now be able to use a personal computer creatively, you'll also be able to read magazines such as *BYTE*... *INTERFACE AGE*... *POPULAR ELECTRONICS* and *PERSONAL COMPUTING* and fully understand the articles. And, you'll understand how to expand ELF II to give you the exact capabilities you need!

If you work with large computers, ELF II and the *Short Course* will help you understand what they're doing.

Get Started For Just \$99.95, Complete!

\$99.95 ELF II includes all the hardware and software you need to start writing and running programs at home, displaying video graphics on your TV screen and designing circuits using a microprocessor—the very first night—even if you've never used a computer before.

ELF II connects directly to the video input of your TV set, without any additional hardware. Or, with an \$8.95 RF modulator (see coupon below), you can connect ELF II to your TV's antenna terminals instead.

ELF II has been designed to play all the video games you want, including a fascinating new target/missile gun game that was developed specifically for ELF II. But games are only the icing on the cake. The real value of ELF II is that it gives you a chance to write machine language programs—and machine language is the fundamental language of all computers. Of course, machine language is only a starting point. You can also program ELF II with assembly language and tiny BASIC. But ELF II's machine language capability gives you a chance to develop a working knowledge of computers that you can't get from running only

ELF II Gives You The Power To Make Things Happen!

Expanded, ELF II can give you more power to make things happen in the real world than heavily advertised home computers that sell for a lot more money. Thanks to an ongoing commitment to develop the RCA 1802 for home computer use, the ELF II products—being introduced by Netronics—keep you right on the outer fringe of today's small computer technology. It's a perfect computer for engineering, business, industrial, scientific and personal applications.

Plug in the **GIANT BOARD** to record and play back programs, edit and debug programs, communicate with remote devices and make things happen in the outside world. Add **Kluge** (prototyping) Board and you can use ELF II to solve special problems such as operating a complex alarm system or controlling a printing press. Add **4k RAM Boards** to write longer programs, store more information and solve more sophisticated problems.

ELF II add-ons already include the **ELF II Light Pen** and the amazing **ELF-BUG Monitor**—two extremely recent breakthroughs that have not yet been duplicated by any other manufacturer.

The **ELF-BUG Monitor** lets you debug programs with lightning speed because the key to debugging is to know what's inside the registers of the microprocessor. And, with the **ELF-BUG Monitor**, instead of single stepping through your programs, you can now display the entire contents of the registers on your TV screen. You find out immediately what's going on and can make any necessary changes.

The incredible **ELF II Light Pen** lets you write or draw anything you want on a TV screen with just a wave of the "magic wand." Netronics has also introduced the **ELF II Color Graphics & Music System**—more breakthroughs that ELF II owners were the first to enjoy!

ELF II Tiny BASIC

Ultimately, ELF II understands only machine language—the fundamental coding required by all computers. But, to simplify your relationship with ELF II, we've introduced an **ELF II Tiny BASIC** that makes communicating with ELF II a breeze.

Now Available! Text Editor, Assembler, Disassembler And A New Video Display Board!

The Text Editor gives you word processing ability and the ability to edit programs or text while it is displayed on your video monitor. Lines and characters may be quickly inserted, deleted or changed. Add a printer and ELF II can type letters for you—error free—plus print names and addresses from your mailing list!

ELF II's **Assembler** translates assembly language programs into hexadecimal machine code for ELF II use. The **Assembler** features mnemonic abbreviations rather than numerics so that the instructions on your programs are easier to read—this is a big help in catching errors.

ELF II's **Disassembler** takes machine code programs and produces assembly language source listings. This helps you understand the programs you are working with... and improve them when required.

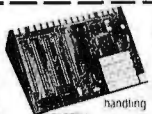
The new **ELF II Video Display Board** lets you generate a sharp, professional 32 or 64 character by 16 line upper and lower case display on your TV screen or video monitor—dramatically improving your unexpanded \$99.95 ELF II. When you get into longer programs, the Video Display Board is a real blessing!

Now Available!

- ☐ **A-D/D-A Board Kit** includes 1 channel (expandable to 4) D-A, A-D converters, \$39.95 plus \$2 postage & handling.
- ☐ **PILOT Language**—A new text-oriented language that allows you to write educational programs on ELF II with speed and ease! Write programs for games... unscrambling sentences... spelling drills... "fill in the missing word" tests, etc. PILOT is a must for any ELF II owner with children. **PILOT Language on cassette tape, only \$19.95 postpaid!**
- ☐ **Game Package** on cassette tape (requires 4k RAM), \$9.95 plus \$2 postage & handling.

Clip Here and Attach to Your Order Below!

PHONE ORDERS ACCEPTED!
Call (203) 354-9375



Netronics R&D Ltd., Dept PE-10
333 Litchfield Road, New Milford, CT 06776

Yes! I want my own computer! Please rush me—

- ☐ **RCA COSMAC ELF II** language, it's a learning breakthrough for engineers and laymen alike \$59.95 postpaid
- ☐ **Deluxe Metal Cabinet** with plexiglas dust cover for ELF II, \$29.95 plus \$2.50 p&h.
- ☐ **I am also enclosing payment** (including postage & handling) for the items checked below!
- ☐ **I want my ELF II wired and tested with power supply, RCA 1802 User's Manual and Short Course—all for just \$149.95 plus \$3 p&h.**

ALSO AVAILABLE FOR ELF II

- ☐ **GIANT BOARD™** kit with cassette I/O. RS 232, C/T/T I/O, 8-bit P/I/O decoders for 14 separate I/O instructions and a system monitor/editor. \$39.95 plus \$2 p&h
- ☐ **Kluge** (Prototype) Board accepts up to J6 IC's \$17.00 plus \$1 p&h
- ☐ **4k Static RAM** kit. Addressable to any 4k page to 64k. \$89.95 plus \$3 p&h
- ☐ **Gold plated 85-pin connectors** (one required for each plug-in board) \$5.70 ea. postpaid
- ☐ **Expansion Power Supply** (required when adding 4k RAM) \$34.95 plus \$2 p&h
- ☐ **Professional ASCII Keyboard** kit with 128 ASCII upper/lower case set 96 printable characters, onboard regulator, parity logic selection and choice of 4 hand-shaking signals to mate with almost any computer. \$64.95 plus \$2 p&h
- ☐ **Deluxe metal cabinet for ASCII Keyboard**, \$19.95 plus \$2 p&h
- ☐ **Video Display Board** kit lets you generate a sharp, professional 32 or 64 character by 16 line upper and lower case display on your TV screen or video monitor—dramatically improving your unexpanded \$99.95 ELF II. (fits inside ASCII Keyboard cabinet) \$89.95 plus \$2 p&h
- ☐ **ELF II Tiny BASIC** on cassette tape. Commands include SAVE, LOAD, etc. X, +, -.

- ☐ **26 variables A-Z, LET, IF/THEN, INPUT, PRINT, GO TO, GOSUB, RETURN, END, REM, CLEAR, LIST, RUN, PLOT, PEEK, POKE**. Comes fully documented and includes alphanumeric character generator required to display alphanumeric characters directly on your screen with or without additional hardware. Also plays tick-tack-toe plus a drawing game that uses ELF II's hex keyboard as a joystick. 4k memory required. \$14.95 postpaid
- ☐ **Tom Pittman's Short Course on Tiny Basic** for ELF II. \$5 postpaid
- ☐ **ELF-BUG™ Deluxe System Monitor** on cassette tape. Allows displaying the contents of all registers on your TV at any point in your program. Also displays 24 bytes of memory with full addresses, blinking cursor and auto scrolling. A must for the serious programmer! \$14.95 postpaid
- ☐ **Text Editor** on cassette tape gives you the ability to insert, delete or edit lines and words from your programs while they are displayed on your video monitor. (Add printer and you can use ELF II to type error-free letters plus insert names and addresses from your mailing list) \$19.95 postpaid
- ☐ **Assembler** on cassette tape translates assembly language programs into hexadecimal machine code for ELF II use. Memorable abbreviations for instructions (rather than numerics) make programs easier to read and help prevent errors. \$19.95 postpaid
- ☐ **Disassembler** on cassette tape takes machine code

- programs and produces assembly language source listings to help you understand and improve your programs \$19.95 on cassette tape
- SAVE \$9.90**—Text Editor, Assembler & Disassembler packaged together, only \$49.95! (Require Video Display Board plus 4k memory.)
- ☐ **ELF II Light Pen**, assembled & tested, \$7.95 plus \$1 p&h
- ☐ **ELF II Color Graphics & Music System Board** kit \$49.95 plus \$2 p&h
- ☐ **ELF II** connects directly to the video input of your TV set without additional hardware. To connect ELF II to your antenna terminals instead, order **RF Modulator**, \$8.95 postpaid

Coming Soon: A-D, D-A Converter, Controller Board and more!

Print Name _____
Address _____
City _____
State _____ Zip _____

Total Enclosed \$ _____
(Conn. res. add tax)
CHARGE IT! Exp. Date _____
☐ Visa ☐ Master Charge
(Bank # _____)
Account # _____

watts then allowed. The AT-1 was designed for crystal-controlled operation, since Novices were then restricted from using VFO (variable frequency oscillator) control. Sporting a three-tube lineup—a 5U4G rectifier, a 6AG7 oscillator-multiplier, and a mighty 6L6 power amplifier with a link-coupled output tank circuit—the set was billed by Heath as the "best dollar-per-watt buy on the market." Priced at \$29.50, FOB Benton Harbor, it probably was. The accessory AC-1 single-wave antenna tuner was all of \$14.50.

Once upgraded to General, the ex-Novice almost certainly put together the accessory VF-1 VFO kit, which afforded him across-the-bands flexibility for an additional \$19.50 (the VFO was designed to simply plug into the AT-1). TVI was a problem for our beginner, especially when he attempted to operate on the three highest of the AT-1's bands, which the 6L6 final amplifier reached by "doubling" the input frequency. Efficiency was thus reduced, and copious harmonics that fell into the TV channels were generated.

Our now more experienced ham soon realized the operating drawbacks of his equipment. Shortly after he shucked his 1-year nonrenewable Novice ticket, he saw that a deeper investment would be prudent. So he searched the local ham shops, checked out the rigs of neighboring amateurs, and scoured the mail-order catalogues of such outfits as World Radio Laboratories, Walter Ashe, Allied Radio, and Fort Orange Radio Distributing Company for gear more fitting his new status as a General ticket-holder. Extremely popular receivers of this period were several of Hallicrafters' popular SX-series; the Hammarlund HQ-line; the RME 4300 and 6900; and better National sets such as the NC-300 "dream receiver," to highlight but a few. Well-heeled hams plunked down greenbacks for sets like the Hammarlund Super Pro or Pro-310, the National HRO-60 or NC-400, or the TMC (Technical Materiel Corp.) GPR-90. All these sets used tubes, and many of the top-of-the-line receivers compete favorably even today with the current crop of imported, solid-state sets.

Once the receiver was upgraded, the next step was a better transmitter (few transceivers were around then). The E. F. Johnson Company entered the market about this time with several very impressive transmitters—probably the first that could be purchased either as kits or as fully-assembled, ready-to-go rigs. Beginning with the Viking I and Viking II, Johnson rapidly added high-quality AM and CW transmitters such as the Valiant, Pacemaker, Challenger, Adventurer, Invader and many others that could take care of almost any ham need. Very likely, the new General operator settled on the Viking Ranger, Johnson's compact, 75-watt CW, 65-watt AM phone transmitter—a good buy, as it turned out. With bandswitching from 160 through 10 meters, the set had a stable, built-in VFO (one of the first), and smooth break-in CW keying circuitry. The kit came complete with tubes for \$229.50, and the wired and tested version cost \$100 more.

Still Good Today? Is this equipment hopelessly antiquated, suitable only for nostalgic recollection and a place on a closet's top shelf? Not at all! In good condition, much of the tube-heavy gear of the 50s and 60s does have a place in the newcomer's ham shack.

(Continued on page 96)

CIRCLE NO. 39 ON FREE INFORMATION CARD



Light years ahead

with information on software, hardware, simulations, circuit design, robotics, languages and compilers, computer games, custom systems design and a universe of applications.

Through each exciting issue of BYTE, the leading magazine in the personal computer field, you'll be kept informed of the latest fast-paced changes taking place within the ever-expanding universe of microprocessors. You'll be way ahead with reports on home computer applications, tutorials, and computer product reviews.

BYTE's editorials explore in depth the fun of using and applying computers for personal satisfaction in activities as wide ranging as electronic music, electronic mail,

computer games, and practical personal business programs. Each monthly issue has authoritative yet easily read coverage of principles of hardware and software design, approaches to novel applications, and essential articles of interest to personal computer enthusiasts. Expand your mind with BYTE!

Read your first copy of BYTE. If it is everything you expected, honor our invoice. If it isn't, just write cancel on the invoice and mail it back. You won't be billed, and the first issue is yours to keep at no charge.

BYTE

The Small Systems Journal

BYTE® Subscription Dept. P.O. Box 590 Martinsville, N.J. 08836

United States ☐ One year \$18 (12 issues) ☐ Two years \$32 ☐ Three years \$46

Canada or Mexico ☐ One year \$20 (12 issues) ☐ Two years \$36 ☐ Three years \$52

☐ CHECK ENCLOSED (Entitles me to 13 issues for price of 12, North America only)

☐ Bill Visa ☐ Bill Master Charge ☐ Bill me (North America only)

Card Number _____ Expires _____

Signature _____ Name (please print) _____

Address _____

City _____ State/Province/Country _____ Code _____

Foreign Rates (To expedite service, please remit in U.S. funds drawn on a U.S. bank)

☐ Europe, one year, air delivered \$32 ☐ Other countries, one year, surface delivered \$32.

Air delivery available upon request.

73A9

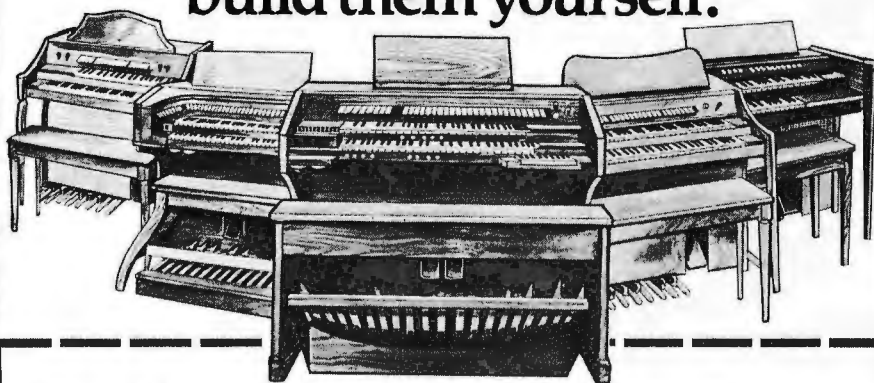
Allow 6 to 8 weeks for processing your subscription. If you have any questions, call the BYTE Subscription Department between 8:30 AM and

4:30 PM (ET), Monday through Thursday and until noon on Friday. Dial Toll Free (within continental U.S.) 800-258-5485. NH residents dial 1-924-7217.

© BYTE Publications, Inc. 1979

CIRCLE NO. 14 ON FREE INFORMATION CARD

**They look expensive.
They sound expensive.
But they're not because you
build them yourself.**



The Magnificent Schober Electronic Organs.

Imagine the pride and joy of owning one of the world's great organs. And for up to 50% less than an instrument of comparable sound and quality. Schober organ kits come in 5 different styles and sizes to fit your musical taste and budget.

Mail this coupon today for free information.

The Schober Organ Corp., Dept. PE-85
43 West 61st Street, New York, N.Y. 10023

☐ Send me free catalog. ☐ Enclosed is \$1 for your 12" demo record.

Name _____

Address _____

City _____ State _____ Zip _____

CIRCLE NO. 51 ON FREE INFORMATION CARD



10% OFF

Radio Shack TRS-80
and accessories (full warranty)

Complete line of printers
and disk systems for TRS-80

Best price and delivery on

Exidy Sorcerer®

— CALL US! —

SAVE 15% on
North Star Horizon
and Cromemco

— WRITE FOR FREE CATALOG —

MiniMicroMart

1618 James St., Syracuse NY 13203
(315) 422-6666 TWX 710-541-0431

CIRCLE NO. 35 ON FREE INFORMATION CARD

(Continued from page 94)

He can, indeed, save a great deal of money by purchasing older equipment, which sells for but a small fraction of its showroom ticket. Using 50s equipment and accessories, he can likely get on the air for \$100 or 150; perhaps less. Of course, most of the older AM-only transmitters and cheapie "clunker" receivers are passe, but many of the "quality gear" of the era are suitable for use today.

This is especially true of older CW transmitters, particularly those having built-in VFOs and a fair amount of power. Most of them were well-engineered and are still good "first rig" buys for the Novice or Technician who wishes to "get his feet wet" on CW. Perfectly suitable for CW work (forgetting any of the rig's AM capabilities) would be transmitters such as the Heath DX-100 and TX-1, the Collins 32V2 and 32V3, the Ranger I and II, Valiant I and II, the Navigator, Globe Scout, and Globe King 500. Also usable are several of the Allied Radio/Knight-kit rigs such as the T-50, T-60, and T-150.

As for receivers, the best, most expensive ones were far ahead of their times and are still good bets despite major technological advances. Among these are the National HRO-60 and NC-400; the Hammarlund SP-600, Pro-310, and HQ 145, 170 and 180; the Hallicrafters SX-88, SX-100 and SX-101; and the Collins 75A3 and 75A4.

What to Look For. If you're interested in outfitting your shack with some of the older gear, be sure you know what you are getting and that the price is fair and reasonable. Realize that most older sets will need some work to get them on the air (at least an alignment and tube-check) and that the separate transmitter and receiver set-up will require a TR (transmit-receive) switch or relay.

The best way to buy is probably from a friend who is a ham or through an established dealer. Other possibilities are the "for sale" columns in the various ham magazines, swap-and-sale newsletters, hamfest swap meets, and radio-club auctions. Don't buy what is obviously butchered or junked, and be especially cautious about kit-constructed gear. Check out the "insides" before clinching a deal, and ask for a service manual in hopes that the seller still has one. Finally, rely on the advice of an older, more experienced amateur; he may have at one time owned and operated exactly the equipment you're looking for.

A good way to learn about the specs of these old sets is to read the ads and product reviews in the back issues of the ham magazines. Scan the back issues at your local library, or better yet, scan the hamfests for back issues of the old magazines yourself, and build your own file. Old issues can usually be obtained for 5 or 10 cents a copy and they make for good reading as well.

If some of the "Golden Oldie" equipment strikes your fancy, don't feel outdated or embarrassed. In fact, once you start to look around, you'll find that the best of the old gear is being chased by those who recognize a good buy. Moreover, some may even be in short supply. Many hams take the same pride in operating "classic" equipment as do old-time car buffs, and you may be surprised to find that the payoff in operating satisfaction and downright "fun" is far greater than with modern equipment. Old gear may give your hobby a new twist. ◇

J&R
THE ONE-STOP MUSIC SHOP AT WHOLESALE PRICES

**MINIMUM ORDER 12 TAPES
100% GUARANTEED**

BLANK TAPES
CASSETTE TAPES

Ampex Grand Master II C-90	\$3.11
Ampex Grand Master I C-90	\$2.79
BAF Studio C-90	\$2.69
BAF Professional II or III C-90	\$2.99
Maxell UD C-90	CALL
Maxell UDXL I or II C-90	CALL
Maxell UDXL I or II C-90	CALL
Scotch tape note (Dynaram)	\$2.84
C-90 / 3 pk. C-90	\$4.99 for 3
Scotch Master II C-90	\$2.84
Scotch Master II or III C-90	\$3.29
Sony Fairchild C-90	\$3.68
TDK D C-90	\$1.68
TDK D C-120	\$2.10
TDK D C-180	\$2.99
TDK AD C-90	\$2.62
TDK AD C-120	\$2.22
TDK SA C-90	\$3.19

REEL-TO-REEL

Maxell UD 35-90 1800 ft.	CALL
Maxell UDXL 35-90 1800 ft. CALL	
Maxell UD 35-180 3600 ft.	CALL
Scotch 212 1800 ft.	\$4.35
Scotch 207 1800 ft.	\$6.19
TDK L-1800 1800 ft.	\$5.22

VIDEO TAPES

BETA FORMAT

TDK L-500 (2 Hour)	\$13.75
Sony L-750 (2 Hour)	\$16.95
Sony L-500 (2 Hour)	\$13.95
Scotch L-500 (2 Hour)	\$13.50
Zenith L-500 (2 Hour)	\$13.95
Ampex L-500 (2 Hour)	\$12.95

VHS FORMAT

Scotch VK-250 (4 Hour)	\$17.95
JVC T-120 (4 Hour)	\$18.75
TDK T-120 (4 Hour)	\$19.50
Full T-120 (4 Hour)	\$17.00
RCA VK-250 (4 Hour)	\$18.95
RCA VK-125 (2 Hour)	\$14.95
Panasonic NVT-120 (2 Hour)	\$16.95
Panasonic NVT-60 (4 Hour)	\$14.95

Call or write for super low prices on Maxell tapes.

CARTRIDGES
audio-technica

AT-20 SS	\$129.50
AT-16 SS	\$89.90
AT-14 SA	\$48.95
AT-12 SA	\$4.90
AT-10	\$12.00

SHURE

M55HE	\$34.95
V15 TYPE IV	\$89.90
V15 TYPE III	\$64.95
M55ED	\$29.75
M91ED	\$21.00
M44E	\$13.80
M70EJ	\$9.90

PICKERING

XSV3000	\$49.95
XV15 120DE	\$39.95
XV15 750E	\$32.50
XV11LC	\$25.71
XV15 400E	\$22.45

HEADPHONES
SENNHEISER

HD-420	\$50.88
HD-430	\$74.40
HD-400	\$26.28
HD-414	\$44.88
HD-424	\$65.28

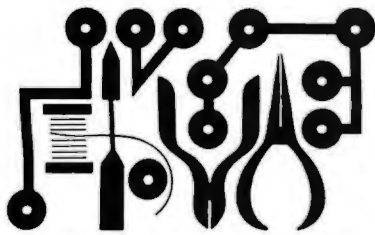
KOSS

PRO 4AA	\$39.90
PRO 4 AAA	\$48.00
HV1	\$29.97
K/6A	\$19.97

HOW TO ORDER: For shipment within 48 hours, send money order or certified check. Two weeks delay on personal checks. Please add \$3.50 per order for shipping & handling. (\$5.50 for orders outside U.S.). N.Y.S. residents add tax. No C.O.D.'s. All merchandise 100% guaranteed, brand new & factory fresh.

J&R MUSIC WORLD
33 PARK ROW, DEPT. PE, NEW YORK, N.Y. 10038
ORDER TOLL FREE (800) 221-8180
CALL OR WRITE FOR FREE 120 PAGE CATALOG

CIRCLE NO. 30 ON FREE INFORMATION CARD



Experimenter's Corner

By Forrest M. Mims

VOLTAGE-TO-FREQUENCY CONVERTERS

MANY INTERESTING circuit applications have been made possible by some relatively new monolithic ICs that convert volt-

a fixed time interval determined by the values of timing components R_T and C_T . Depending on many factors, this one injection of charge

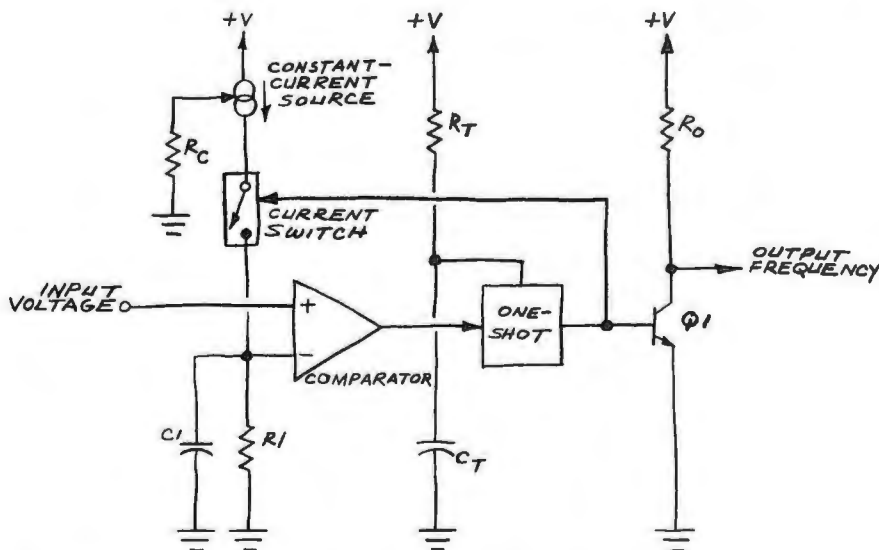


Fig. 1. Functional diagram of a typical voltage-to-frequency converter.

ages applied to their inputs into pulse trains whose frequencies vary in step with changes in the input voltages. In the past, voltage-to-frequency or simply V/F converters were available only as expensive hybrid modules or do-it-yourself patchwork versions made from IC timers and op amps. This month, we'll look at several straightforward applications for two new V/F chips. Because these chips can also function as frequency-to-voltage (F/V) converters, those applications will be covered in a future issue.

V/F Converter Basics. Figure 1 is a simplified block diagram of a basic V/F converter. The circuit functions as a relaxation oscillator whose frequency is determined by the voltage applied to the noninverting input of the comparator. If capacitor C_1 is initially discharged, the output of the comparator will switch to the positive supply voltage as soon as the input voltage becomes positive. This triggers a one-shot timer that closes a switch to connect a constant current source to C_1 for

might develop a voltage across C_1 that is more positive than the input voltage. If this happens, the one-shot will not be triggered again and will remain in its "off" state. The comparator will continue to monitor the input.

This charging cycle will be repeated any time the input voltage becomes more positive than that across C_1 . In the meantime, C_1 is gradually discharged by R_1 . Should the voltage across C_1 fall below the input voltage, the charge sequence will be repeated—even if the input voltage has not changed.

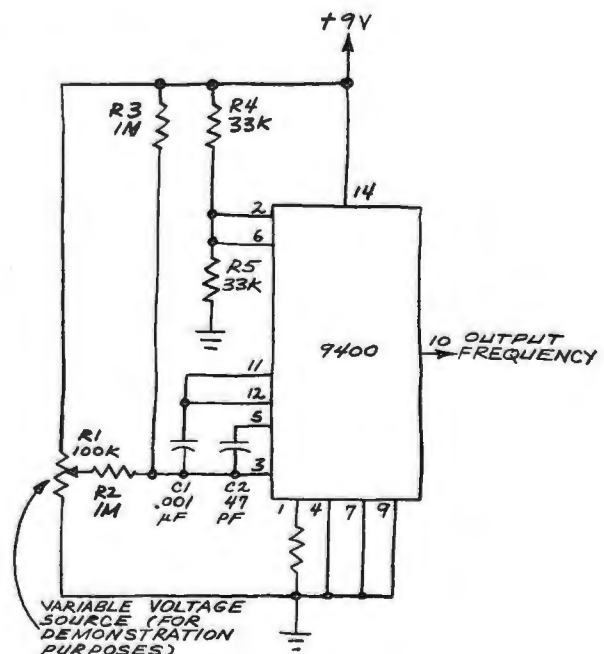
This automatic tracking process, known as *charge balancing*, enables the circuit to generate a pulse train whose frequency is precisely proportional to the input voltage. The output pulses developed by the one-shot timer are buffered by transistor Q_1 .

This is a highly simplified description of how most V/F converters work. For more details, see Walter G. Jung's "IC Timer Cookbook" (Howard W. Sams and Co., 1977, pp. 184-192). The data sheets for the various V/F ICs also include good explanations of how they operate.

Teledyne 9400 V/F Converter. This 14-pin DIP incorporates both CMOS and bipolar circuitry on a single silicon substrate. The result is very low current consumption, typically 3.5 mA when the IC is powered by a single 9-volt battery. The chip can, however, be powered by either a dual- or single-polarity supply. Figure 2 is the schematic of a V/F converter made with a 9400 and some external parts. The circuit, which is powered by a single-ended supply, was adapted from one appearing in the manufacturer's data sheet.

A breadboard version that I assembled began to emit an output signal with a frequency of 0.3 Hz when the input voltage reached 0.25 volt. The maximum input voltage to which the circuit would respond was exactly 8 volts when the circuit was powered by a 9-volt alkaline battery. The output frequency corresponding to this input voltage was 13.53 kHz. A plot of the output frequency versus the

Fig. 2. Voltage-to-frequency converter using a 9400 IC.



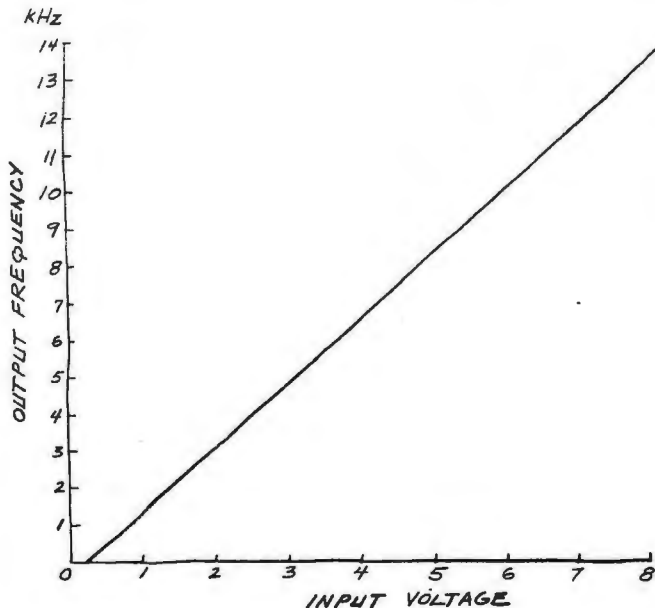


Fig. 3. Output frequency vs. input voltage for 9400 V/F converter circuits.

input voltage at half-volt intervals for the prototype circuit is shown in Fig. 3. The striking linearity of this chip's output-frequency/input-voltage characteristic, which in this case extends over a five-decade frequency range, is characteristic of V/F ICs.

The output frequency of the circuit in Fig. 2 can be increased to a maximum of 100 kHz by reducing the values of C1, C2 and R2. The 9400 data sheet gives detailed information.

9400 Digital Data Transmission. Frequency shift keying (FSK) is a complicated name for a very simple way to transmit digital data. In most digital electronic circuits, the logic 0's and 1's of a binary signal are represented by two voltage levels. FSK data transmission assigns one audio-frequency tone to logic 0 and a second (usually higher) frequency to logic 1.

This permits a stream of bits to be transmitted over a pair of wires, by radio, or by light. At the receiver, a frequency-to-voltage (F/V) converter transforms the received tones back into two distinct voltage levels.

A block diagram of a basic FSK data transmission system is shown in Fig. 4.

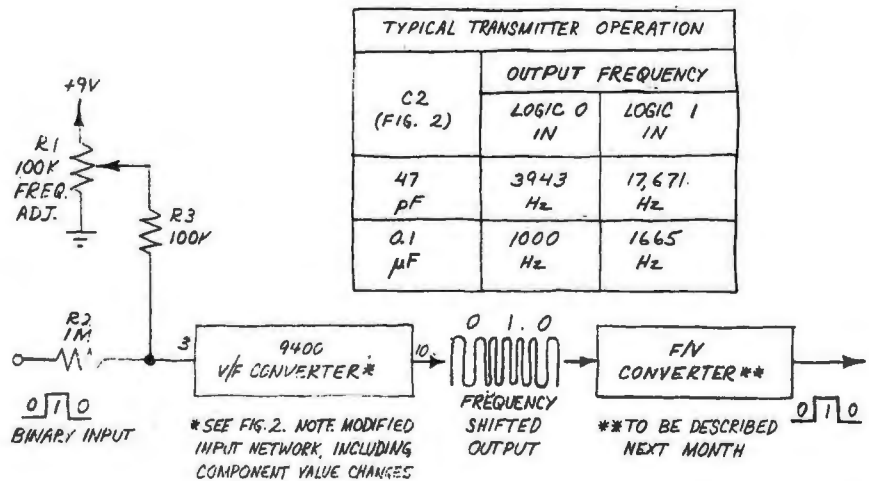


Fig. 4. A 9400 FSK binary data transmission system.

mission system is shown in Fig. 4. Potentiometer R1 in the transmitter input network permits the quiescent output frequency to be preset to any convenient value. This permits

many different FSK transmitters, each with different 0 and 1 frequencies, to share a common transmission channel. Of course, each information (not transmission) channel will require a separate FSK receiver.

9400 Frequency Modulator. Several articles in this magazine have described ways of transmitting information over a pulse/frequency-modulated beam of infrared radiation emitted by a LED or injection laser. This method of light-beam modulation is superior to amplitude modulation because each pulse transmitted has the same amplitude, usually the maximum signal power the transmitter can radiate. The received signal is not as subject to fading as that in an AM system when propagation conditions change or when the transmitter-to-receiver distance changes.

The 9400 and other V/F converters can be used as exceptionally linear frequency modulators. Figure 5, for example, shows a basic FM transmitter that will transform an audio signal such as voice into a train of variable-frequency pulses suitable for driving a LED or modulating a radio transmitter.

Note that the duration of the pulses in the output signal is variable. For several reasons, it's desirable to drive a LED with pulses of

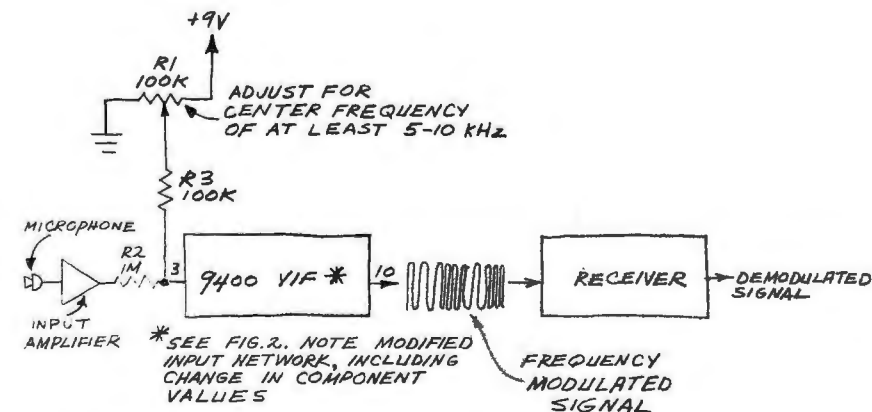


Fig. 5. A 9400 frequency-modulated transmitter.

uniform duration, especially in a long-range voice-communication system in which the LED is driven by ampere-level current pulses.

The circuit shown in Fig. 5 can easily be modified to accomplish this purpose. One possibility is to connect its output to a one-shot that delivers a pulse of uniform duration to the LED each time a pulse is generated by the 9400. Another is to trigger the gate of an SCR which, in turn, dumps the charge that has accumulated in a capacitor through the LED. Still another method is to trigger a transistor which then dumps charge from a capacitor through the LED. Whichever means you select, it's important to make sure that the pulses from the one-shot are not too wide. Otherwise, some of the closely spaced pulses generated by the 9400 will be missed, resulting in distortion.

The frequency modulated signal must be demodulated after it is received. One way to accomplish demodulation is to connect a one-shot to the receiver output, the method employed in the P/FM laser receiver described in the 1979 *Electronic Experimenter's*

Popular Electronics

NEW
SUBSCRIBERS
ONLY

CREDITS

The sum of \$6 and 03 cts

TO THE ACCOUNT OF:

☐ Send POPULAR ELECTRONICS for one year (12 issues) for just \$6.97. That's 40% off the annual newsstand rate of \$15.

Mr. _____
Mrs. _____
Ms. _____ (please print full name) 45564

Address _____ Apt. _____

☐ Two years only \$16.97—43% off the 2 year newsstand rate of \$30.

City _____

☐ Three years only \$22.97—49% off the 3 year newsstand rate of \$45.

State _____ Zip _____

49171 ☐ Send me one year of *Popular Photography* for \$6.99.

CHECK ONE: ☐ Payment enclosed.
☐ Bill me later.

Foreign postage: Add \$3 a year for Canada. Add \$5 a year (cash payment in U.S. currency only) for other countries outside U.S. and possessions. Please allow 30 to 60 days for delivery of first issue.

Popular Electronics

NEW
SUBSCRIBERS
ONLY

CREDITS

The sum of \$6 and 03 cts

TO THE ACCOUNT OF:

☐ Send POPULAR ELECTRONICS for one year (12 issues) for just \$6.97. That's 40% off the annual newsstand rate of \$15.

Mr. _____
Mrs. _____
Ms. _____ (please print full name) 45564

Address _____ Apt. _____

☐ Two years only \$16.97—43% off the 2 year newsstand rate of \$30.

City _____

☐ Three years only \$22.97—49% off the 3 year newsstand rate of \$45.

State _____ Zip _____

49171 ☐ Send me one year of *Popular Photography* for \$6.99.

CHECK ONE: ☐ Payment enclosed.
☐ Bill me later.

Foreign postage: Add \$3 a year for Canada. Add \$5 a year (cash payment in U.S. currency only) for other countries outside U.S. and possessions. Please allow 30 to 60 days for delivery of first issue.



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 906 BOULDER COLORADO

POSTAGE WILL BE PAID BY ADDRESSEE

Popular Electronics

P.O. Box 2774
Boulder, Colorado 80321



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 906 BOULDER COLORADO

POSTAGE WILL BE PAID BY ADDRESSEE

Popular Electronics

P.O. Box 2774
Boulder, Colorado 80321



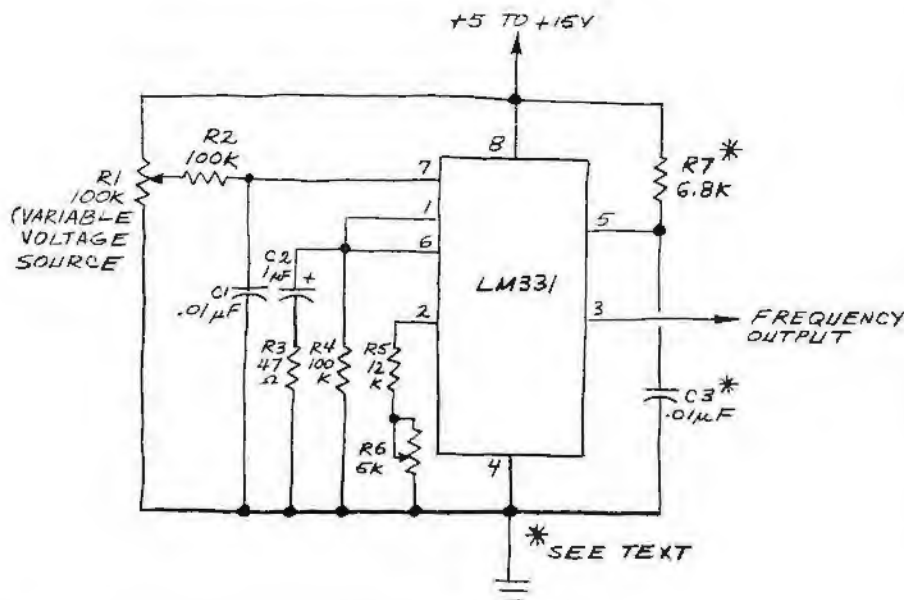


Fig. 6. Voltage-to-frequency converter using an LM331.

Handbook (F. Mims, "Semiconductor Laser Communications System," pp. 64-73). Another demodulation system employs a phase-locked loop, a method covered in a prior installment of "Experimenter's Corner" ("Pulse Modulation and Phase-Locked Loops," May 1976, pp. 101-102). That column also described a simple two-transistor P/FM LED transmitter.

There's insufficient space in this column to cover 9400 V/F frequency modulators in detail. If you would like to see a construction story or a column describing in detail a P/FM light-wave communication system that employs a 9400 or similar V/F converter, send a postcard with your comments to this column in care of POPULAR ELECTRONICS. If there is sufficient reader interest, I will probably undertake such a project.

National LM331 V/F Converter. After spending a good deal of time experimenting

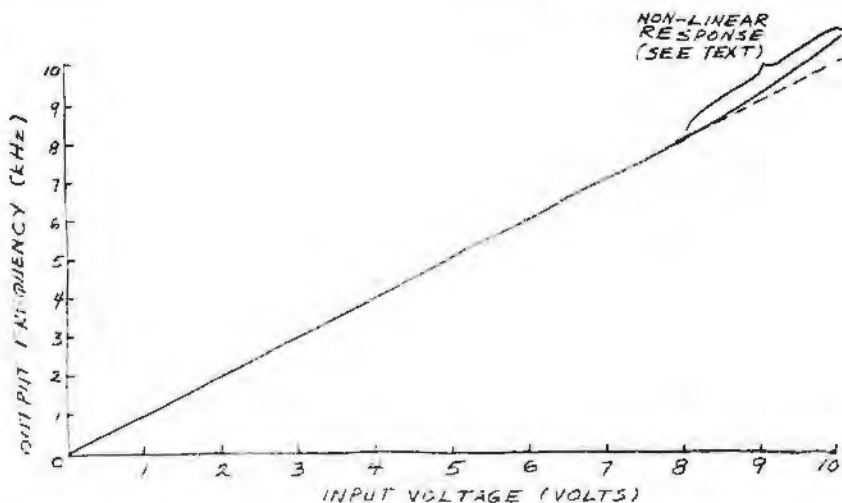


Fig. 7. Output frequency vs. input voltage for LM331 V/F converter.

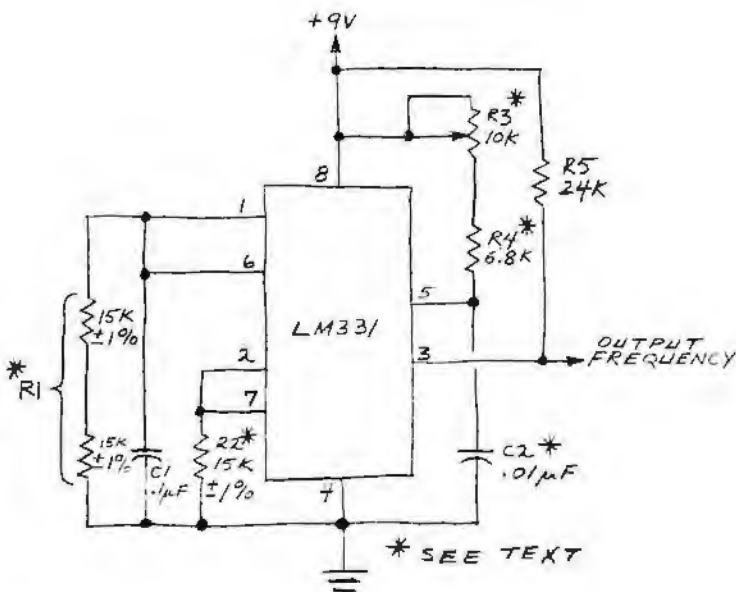


Fig. 8. LM331 operated as stable frequency oscillator.

with the 9400, I received a few sample LM331 V/F converters from Robert A. Pease, a staff scientist for National Semiconductor. The LM331 has a guaranteed linearity of at least 0.01 percent when connected in the V/F mode. Like the Teledyne Semiconductor 9400, it can be operated from a single-ended or dual-polarity supply, and can generate an output frequency of up to 100 kHz.

Figure 6 shows a basic V/F converter adapted from the LM331 data sheet. Potentiometer R1 serves as a voltage divider that delivers a variable input voltage to the V/F circuit. A breadboard version of this circuit yielded the plot of voltage versus frequency shown in Fig. 7. The increasing nonlinearity in V/F operation when the input voltage exceeded 8 volts is probably due to my use of standard-tolerance components. For $\pm 0.03\%$ linearity (typical), use 1% tolerance resistors for R4 and R7 and a low-temperature-coefficient capacitor for C3.

One of the simplest applications for the LM331 is the ultra-stable oscillator shown in Fig. 8. This circuit, which Don Pease of National Semiconductor described in *Electronic*

Design (December 6, 1978, pp. 70-76), has a frequency stability of ± 25 parts per million per degree Centigrade (ppm/C) if low-temperature-coefficient parts are used for R3, R4 and C2. These components determine the output frequency of the oscillator.

Note that R1 is composed of two 15,000-ohm resistors in series. Don recommends that these resistors and the one used for R2 be from the same production batch. This makes the circuit from five to ten times more immune to temperature changes than it would be if R1 were a single 30,000-ohm resistor. Incidentally, although these resistors should have a tolerance of no more than 1% for best results, the circuit will operate (but with less accuracy) if standard 10% tolerance resistors are used.

Like the 9400, the LM331 is not yet readily available from many of the hobby distributors who advertise in this magazine, but it will be as soon as the demand exists. Until then you can get the LM331 from Hamilton/Avnet, Schweber, Hall Mark, Sterling or any of the dozens of major industrial distributors who handle National Semiconductor parts. ◇

By Netronics

ASCII/BAUDOT,
STAND ALONE



Computer Terminal

COMPLETE
FOR ONLY
\$149⁹⁵

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requiring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: 1.5 P/P into 75 ohm (EIA RS-170) • **Baud Rate:** 110 and 300 ASCII • **Outputs:** RS232-C or 20 ma. current loop • **ASCII Character Set:** 128 printable characters—

aB7G€B+JvW\$W020123456789:;<=>?
 !"#\$%&'()*+,-./0123456789:;<=>?
 EFBCDEFGHIJKLHOPQRSTUWVXYZ[\]^_`
 'abcdefghijklmnopqrstuvwxyz{|}~

BAUDOT Character Set: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? * 3 8 () , . 9 0 1 4 1 5 7 ; 2 6 8 *
Cursor Modes: Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing • **Cursor Control:** Erase, End of Line, Erase of Screen, Form Feed, Delete • **Monitor Operation:** 50 or 60Hz (jumper selectable).

Continental U.S.A. Credit Card Buyers Outside Connecticut

CALL TOLL FREE 800-243-7428

To Order From Connecticut Or For Technical Assistance, Etc. Call (203) 354-9375

Netronics R&D Ltd., Dept. PE-10
333 Litchfield Road, New Milford, CT 06776

Please send the items checked below—

- ☐ Netronics Stand Alone ASCII Keyboard/Computer Terminal Kit, \$149.95 plus \$3.00 postage & handling.
- ☐ Deluxe Steel Cabinet for Netronics Keyboard/Terminal In Blue/Black Finish, \$19.95 plus \$2.50 postage and handling.
- ☐ Video Display Board Kit alone (less keyboard), \$89.95 plus \$3 postage & handling.
- ☐ 12" Video Monitor (10 MHz bandwidth) fully assembled and tested, \$139.95 plus \$5 postage and handling.
- ☐ RF Modulator Kit (to use your TV set for a monitor), \$8.95 postpaid.
- ☐ 5 amp Power Supply Kit In Deluxe Steel Cabinet (±8VDC @ 5 amps, plus 6-8 VAC), \$39.95 plus \$2 postage & handling.

Total Enclosed (Conn. res. add sales tax) \$

By—
☐ Personal Check ☐ Cashiers Check/Money Order
☐ Visa ☐ Master Charge (Bank # _____)

Acct. # _____
 Signature _____ Exp. Date _____

Print Name _____
 Address _____

City _____
 State _____ Zip _____

☐ Send Me More Information

CIRCLE NO. 37 ON FREE INFORMATION CARD



Computer Bits

By Leslie Solomon
Technical Director

MODERN MUSIC

WE HAVE recently had opportunities to test many computer "plug-in" music systems. Like so many other computer peripherals, music boards have been evolving rapidly and have come a long way from those that could handle only a couple of octaves in a single raspy "voice" and play only one melody for a minute or so. Now, the number of voices has increased, and the duration of the melodies depends only on the amount of RAM available. Software has also become more complex so that just about all musical parameters can be controlled. Some music programs have the appearance of high-level language and require no computer expertise.

One of the newest music systems is the ALF Music Synthesizer, which is compatible with the Apple II and is \$265 from ALF Products (1448 Estes, Denver, CO 80215; Tel: 303-234-0871). Available from Apple dealers, this single-board plug-in is a three-voice synthesizer with hardware control of pitch and volume. All other effects are controlled by software. It also takes advantage of Apple graphics in a unique manner. Audio range is eight octaves.

The system requires a 32K Apple II, a cassette recorder and an external hi-fi audio system. Stereo provisions are made and up to nine voices (using three boards) can be handled. The cassette furnished with the board contains two (integer) BASIC programs, four two- and three-voice melodies, programs for use with a disk, and an extended playing program.

The first program, called "Introduction," explains basic music synthesizer terminology,

and provides some hands-on experiments to illustrate the concepts. The second program, called "Entry," is used to enter and play melodies—either from the cassette or created by the user. When "Entry" is run, a high-resolution graphics display appears on the monitor. Since the image does not require color, a good monochrome CRT is suggested.

Unlike older music systems where non-musical combinations of letters, digits and other symbols are used to specify a particular note or other parameter, the ALF board actually displays the treble and bass staves. Along the bottom of the display is a set of seven musical notes (from a whole note to a 64th) a dot (time) modifier, and a "3" modifier that causes the selected note to be multiplied by 3. Also shown are the three accidentals (sharp, flat, and natural), a rest symbol, right and left arrows, and a speaker symbol.

An up-arrow cursor, controlled by paddle-0, can be positioned under the desired symbol, while a "flying saucer" symbol, controlled by paddle-1, can be positioned as desired on the staves. The display is completed by three editing commands: DEL (delete), INS (insert) and TIE (tie two notes together).

To create a melody, a key is determined by typing in (for example) "KEY:3F" and the three flats appear correctly positioned on each staff. The tempo might then be selected by typing in "TIME:34" and the large 34 would appear in the correct position. All other parameters are determined by typed-in editing commands.

Paddle-0 is positioned to the desired note or other command, and paddle-1 is used to



The ALF Music Synthesizer displays treble and bass staves and various music symbols.

position the "flying saucer" as desired on the staff. The other voices are entered by typing in the Part number. Paddle pushbuttons are used to enter the data. Thus, music is "written" in the conventional way. Once a melody has been either created by the user or taken from the cassette, each measure can be sequentially displayed and, if desired, any element can be modified. Other than the displayed "menu," there is another set of commands that can be typed in for more detailed musical creations. The manual explains all of these commands.

We tested the system on our 32K Apple, along with a monochrome monitor, a cassette recorder, and a hi-fi audio system. A good audio system should be used since the computer music system can produce a wide variety of sound effects—comparable in many respects to an expensive music synthesizer. The user has full control over attack, sustain, decay, and other music parameters.

Each of the four melodies provided on the cassette was loaded and played in turn. The audio portion is surprisingly excellent and provides a new world of sound effects from a low-cost computer plug-in. The video display consists of two to six (depending on the number of voices used) horizontal lines having a bright spot to indicate the position of middle C. As the melody progresses, small blocks of light "dance" in step with each voice. The brightness of each dancing block is determined by the voice amplitude. Although meaningless as far as the music is concerned, the display is fascinating to watch.

After playing the prerecorded melodies, we experimented with our own music. Within about an hour, we had scored our first two-voice fugue (from sheet music). After playing it, we experimented with the various musical parameters and came up with some really strange synthesized tones. If you are serious about computer music, we suggest the use of two (or even three) ALF boards so that you can play six voices in stereo.

There is no doubt that, because it requires no computer know-how, the ALF synthesizer will be greatly appreciated by music students and teachers with access to an Apple II. ALF also makes available a 16-song cassette (\$14.95) that is not only excellent from a music viewpoint, but also provides a good training aid in illustrating the use of six independent voices.

SOL Users Group. Since the demise of Processor Technology, many SOL users have been lacking a source of hardware, software, and maintenance information. These are now available from the Proteus Group, c/o Stan Sokolow, 1690 Woodside Rd., Suite 219, Redwood City, CA 94061 (Tel: 415-368-3331).

RAM "EYE'S." According to Case Western University Robotics Lab., you can use a 1K dynamic RAM chip (of the 4008 family) as a low-cost image sensor. Carefully pry off the thin metal lid, being careful not to damage the tiny internal wiring. Focus an image on the RAM surface and write 1's into the RAM. When you read the RAM, where light fell on the array, there will be 0's and where the array was dark, the 1's will remain. The 4008 is pin-compatible with the 2102, but it needs -12 volts on the ground pin.

System 68. A ferroresonant constant-volt-
OCTOBER 1979

Start Computing For Just \$129.95 With An
8085-Based Professional Computer Kit—

Explorer/85

100% compatible with all 8080A and
8085 software & development tools!

No matter what your future computing plans may be, Level "A"—at \$129.95—is your starting point.

Starting at just \$129.95 for a Level "A" operating system, you can now build the exact computer you want. Explorer/85 can be your beginner's system, OEM controller, or IBM-formatted 8" disk small business system... yet you're never forced to spend a penny for a component or feature you don't want and you can expand in small, affordable steps!

Now, for just \$129.95, you can own the first level of a fully expandable computer with professional capabilities—a computer which features the advanced Intel 8085 cpu, thereby giving you immediate access to all software and development tools that exist for both the 8085 and its 8080A predecessor (they are 100% software compatible)—a computer which features onboard S-100 bus expansion—plus instant conversion to mass storage disk memory with either 5-1/4" diskettes or standard IBM-formatted 8" disks.

For just \$129.95 (plus the cost of a power supply, keyboard/terminal and RF modulator, if you don't have them already), Explorer/85 lets you begin computing on a significant level... applying the principles discussed in leading computer magazines... developing "state of the art" computer solutions for both the industrial and leisure environment.

Level "A" Specifications

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an 8155 ROM-I/O—all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

(Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/Display.)



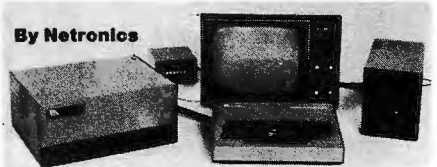
Level "A" at \$129.95 is a complete operating system, perfect for beginners, hobbyists, or industrial controller use.

...cassette tape recorder output...cassette tape control output...speaker output...LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit I/O ports • Crystal Frequency: 6.144 MHz • Control Switches: reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • Counter/Timer: programmable, 14-bit binary • System RAM: 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000 leaving 0000 free for user RAM/ROM. Features include tape load with labeling...tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all registers...single step with register display at each break point, a debugging/training feature...go to execution address...move blocks of memory from one location to another...fill blocks of memory with a constant...display blocks of memory...automatic baud rate selection...variable display line length control (1-255 characters/line)...channelized I/O monitor routine with 8-bit parallel output for high speed printer...serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling...tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all

By Netronics



registers...single step with register display at each break point...go to execution address. Level "A" in the Hex Version makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.



Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys, 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks...address decoding for onboard 8k EPROM expansion select-able in 8k blocks...address and data bus drivers for onboard expansion...wait state generator (jumper select-able), to allow the use of slower memories...two separate 5 volt regulators.



Explorer/85 with Level "B" card cage.

Level "C" Specifications
Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and cards are neatly contained inside Explorer's deluxe steel cabinet.

Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors.

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

Order A Coordinated Explorer/85 Applications Pak!

Experimenter's Pak (SAVE \$12.50)—Buy Level "A" and Hex Keypad/Display for \$199.90 and get FREE Intel 8085 user's manual plus FREE postage & handling!

Student Pak (SAVE \$24.45)—Buy Level "A," ASCII Keyboard/Computer Terminal, and Power Supply for \$319.85 and get FREE RF Modulator plus FREE Intel 8085 user's manual plus FREE postage & handling!

Engineering Pak (SAVE \$41.00)—Buy Levels "A," "B," "C," "D," and "E" with Power Supply, ASCII Keyboard/Computer Terminal, and six S-100 Bus Connectors for \$514.75 and get 10 FREE computer grade cassette tapes plus FREE 8085 user's manual plus FREE postage & handling!

Business Pak (SAVE \$89.95)—Buy Explorer/85 Levels "A," "B," and "C" (with cabinet), Power Supply, ASCII Keyboard/Computer Terminal (with cabinet), 16k RAM, 12" Video Monitor, North Star 5-1/4" Disk Drive (includes North Star BASIC) with power supply and cabinet, all for just \$1599.40 and get 10 FREE 5-1/4" minidiskettes (\$49.95 value) plus FREE 8085 user's manual plus FREE postage & handling!

Continental U.S.A. Credit Card Buyers Outside Connecticut

CALL TOLL FREE 800-243-7428

To Order From Connecticut Or For Technical Assistance, Etc. Call (203) 354-9375

Netronics R&D Ltd., Dept. PE-10

333 Litchfield Road, New Milford, CT 08876

Please send the items checked below—

☐ Explorer/85 Level "A" Kit (ASCII Version), \$129.95 plus \$3 p&h.

☐ Explorer/85 Level "A" Kit (Hex Version), \$129.95 plus \$3 p&h.

☐ 8k Microsoft BASIC on cassette tape, \$64.95 postpaid.

☐ 8k Microsoft BASIC in ROM Kit (requires Levels "B," "D," and "E"), \$99.95 plus \$2 p&h.

☐ Level "B" (S-100) Kit, \$49.95 plus \$2 p&h.

☐ Level "C" (S-100 6-card expander) Kit, \$39.95 plus \$2 p&h.

☐ Level "D" (4k RAM) Kit, \$69.95 plus \$2 p&h.

☐ Level "E" (EPROM/ROM) Kit, \$55.95 plus \$0 p&h.

☐ Deluxe Steel Cabinet for Explorer/85, \$49.95 plus \$3 p&h.

☐ ASCII Keyboard/Computer Terminal Kit (features a full 128 character set, upper & lower case, full cursor control, 75 ohm video output convertible to baudot output, selectable baud rate, RS232-C or 20 ma. I/O, 32 or 64 character by 16 line format, and can be used with either a CRT monitor or a TV set (if you have an RF modulator), \$149.95 plus \$2.50 p&h.

☐ Hex Keypad/Display Kit, \$69.95

plus \$2 p&h.

☐ Deluxe Steel Cabinet for ASCII Keyboard/Terminal, \$19.95 plus \$2.50 p&h.

☐ Power Supply Kit (±8V @ 5 amps) in deluxe steel cabinet, \$39.95 plus \$2 p&h.

☐ Gold Plated S-100 Bus Connectors, \$4.85 each, postpaid.

☐ RF Modulator Kit (allows you to use your TV set as a monitor), \$8.95 postpaid.

☐ 16k RAM Kit (S-100 Board expands to 64k), \$199.95 plus \$2 p&h.

☐ 32k RAM Kit, \$329.95 plus \$2 p&h.

☐ 48k RAM Kit, \$459.95 plus \$2 p&h.

☐ 64k RAM Kit, \$589.95 plus \$2 p&h.

☐ 16k RAM Expansion Kit (to expand any of the above up to 64k), \$139.95 plus \$2 p&h each.

☐ Intel 8085 cpu User's Manual, \$7.50 postpaid.

☐ Special Computer Grade Cassette Tapes, \$1.90 each or 3 for \$5, postpaid.

☐ 12" Video Monitor (10 MHz bandwidth), \$139.95 plus \$5 p&h.

☐ North Star Double Density Floppy Disk Kit (One Drive) for Explorer/85 (includes 3 drive S-100 controller, DOS, and extended BASIC with per-

sonalized disk operating system—just plug it in and you're up and running!), \$699.95 plus \$5 p&h.

☐ Power Supply Kit for North Star Disk Drive, \$39.95 plus \$2 p&h.

☐ Deluxe Case for North Star Disk Drive, \$39.95 plus \$2 p&h.

☐ Experimenter's Pak (see above), \$199.90 postpaid.

☐ Student Pak (see above), \$319.85 postpaid.

☐ Engineering Pak (see above), \$514.75 postpaid.

☐ Business Pak (see above), \$1599.40 postpaid.

Total Enclosed \$ _____

(Conn. res. add sales tax) By—

☐ Personal Check ☐ M.O./Cashier's

Check ☐ Visa ☐ Master Charge

(Bank # _____)

Acct. # _____

Signature _____ Exp. Date _____

Print Name _____

Address _____

City _____

State _____ Zip _____

☐ Send Me Information

Scanner Crystals



IMMEDIATE DELIVERY

**GOLD CASED CRYSTALS
WITH
GOLD PLATED QUALITY**

**SPEED ORDER SERVICE
CALL SUSAN WRIGHT
COLLECT 317-888-7265**

DISTRIBUTOR INQUIRIES INVITED

**American
Electronics
inc.**

173 E. Broadway
Greenwood, Indiana 46142

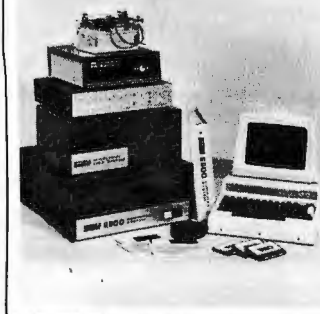
CIRCLE NO. 8 ON FREE INFORMATION CARD

FREE SWTP

CATALOG

**Audio—Computers
Instruments
Kits & Assembled**

**COMPUTER
PRODUCTS
CATALOGUE**



Southwest Technical Products Corporation
219 W. RHAPSODY
SAN ANTONIO, TEXAS 78216

CIRCLE NO. 59 ON FREE INFORMATION CARD

age power supply drives this new computer system. It has an SS-50 motherboard that contains 15 50-pin and eight 30-pin gold-plated connectors. Built around a 6800 CPU, it can accommodate up to four 2708 PROMs and three independent programmable software timers. It comes with up to 16K of software-addressable static RAM board organized into four separately controlled 4K blocks. DIP switches are provided to permit use of existing SWTP and MSI software. Output is video, and the system uses the GMXBUG 3K ROM monitor that contains standard utility functions and routines that facilitate software development. Address: Gimix Inc., 1337 West 37 Pl., Chicago, IL 60609 (Tel: 312-927-5510).

Multiple A/D Conversion. The AIM161 features 16 100-microsecond conversion-time 8-bit analog inputs. It has a three-state output and requires one 8-bit computer output port for control and one 8-bit input port for data. Interfaces are available for PET, KIM, and TRS-80 microcomputers, with others soon to be available for other computers. The A/D converter can be provided with a number of peripherals. These data-acquisition modules (DAMs) are available for \$159 each. Address: Connecticut Microcomputer, 150 Pocomo Rd., Brookfield, CT 06804 (Tel: 203-775-9659).

Video Monitor. The Video-100 is a solid-state video black-and-white monitor using a 12" CRT. Video bandwidth is 12 MHz, and resolution is 650 lines minimum in the central portion of the CRT and 550 lines minimum beyond the central 80% of the screen. Video input is 0.5 volt composite sync at 75 ohms. The monitor is 11½" high, 16¼" wide, and 1½" deep. It weighs 14 lb, and is equipped with all conventional controls. \$149. Address: Leedex Corp., Elk Grove Village, IL 60007 (Tel: 312-364-1180).

Graphics Board. The CGS-808 is a color graphics board for the S-100 bus, or it can stand alone. It contains its own on-board microprocessor, requires no memory space, and eliminates the need for software driver routines. It generates an 8-color display with 12 different programmable and software-selectable modes simultaneously. The alphanumeric mode has an internal character generator to display 32 characters on 16 lines, with two colors per character and inverse video. There is room for an EPROM for custom characters or graphic symbols. Up to 128 different 8-x-12-dot characters can be displayed. Two semigraphic modes have display densities of 64 x 32 and 64 x 48 elements in 8 colors. Eight different graphic modes up to 256 x 192 in two colors are available. Output is composite video at 75 ohms. R-Y, B-Y and Y signals are available for connection to a color monitor. The board comes with software. Address: Biotech Electronics, Box 485, Ben Lomond, CA 95005 (Tel: 408-338-2686).

Selectric Interface. The MP-WP Selectric Interface allows the connection of an unmodified IBM Model-50 Selectric typewriter to an SS-50 bus. Interfacing is made through a cable assembly that plugs into a connector provided on the typewriter. No solenoids or typewriter modifications are required. The typewriter is used as input and output. In-

terface and cable, fully assembled, are \$59.95, postpaid in USA. Address: Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216 (Tel: 512-344-0241).

Multi-System. The Cluster-One is a time-sharing disk system that uses an 8K PET as a host, and is capable of talking to as many as 30 independent and different microcomputers at the same time. Its disk storage features over 630K bytes single-sided and over 1.2 megabytes double-sided. As opposed to conventional time-sharing systems, Cluster-One allows each user to take full advantage of his own computer, so there is little degradation when the system is heavily used. Address: Nestar Systems Inc., 430 Sherman Ave., Palo Alto, CA 94306 (Tel: 415-327-0125).

Winchester Technology. Several readers have asked about the origin of the word "Winchester" when used to describe a particular disk drive. Apparently, early in the development of high-speed hard-disk system, the head was allowed to "float" 31 microinches above the magnetic surface on a cushion of air produced by the disk motion. When the disk stopped, the air cushion vanished, and the head landed on the disk, often causing damage and loss of data.

In 1973, a new design, using a trimaran head structure, allowed the head to float only 19 microinches above the disk, with the entire structure (including hard disk) enclosed in a hermetically sealed package to avoid the possibility of external contamination (dust, grease, etc.). The head loading is so light that it actually rests on the disk when it is motionless and it takes off and lands in an area of the disk reserved for that purpose.

The first such drives of this type from IBM were dual 30-megabyte configurations and called "30-30" systems—thus the name "Winchester." Now, even though the drive capacity has been raised to 70 megabytes, the name persists.

PET Disk. The PEDISK provides both a floppy disk and an S100 expansion chassis in one unit. The expansion feature allows extra I/O, memory, printer, telephone interface, modems, etc. to the PET, while the floppy disk portion allows up to four full-size disk drives (1 megabyte capacity). Prices range from \$799.95 up. Address: CGRS Microtech, Box 368, Southampton, PA 18966 (Tel: 215-757-0284).

SS-50 Video. The Electric Window, a memory-resident and programmable video board that can display up to 80 characters on 24 lines, is now available for 6800 system using the SS-50 bus. It has two character generators—one standard and the other for special characters (APL for example). It also features dual intensity, scrolling, descenders on lower-case letters, programmable display positioning, and programmable interlaced or non-interlaced scan. \$249.95. Address: Percom Data Co. Inc., 211 N. Kirby, Garland, TX 75042 (Tel: 214-272-3421).

Correction. The price of the Pascal Microengine described in our column of August 1979 should have been \$2995, and the correct company address is Computer Interface Technology, 201 W. Dyer Road, Unit C, Santa Ana, CA 92707. ◇

POPULAR ELECTRONICS



Software Sources

By Leslie Solomon
Technical Director

6800 File Management. INDEX (Interrupt Driven EXecutive) operates fast because it services I/O by interrupts rather than polling. I/O devices and other system peripherals are treated as disk files so new devices can be added without modifying the operating system. Besides the 19 built-in commands, INDEX can be expanded by adding utility commands and driver routines. These reside on the diskette and are loaded into memory only when needed. Files can be assigned an activity value as a parameter of file name and both ASCII and binary. Disk files are automatically created, allocated and de-allocated. Files are referenced by names and parameters

are added for name extension, drive number, directory level and include a file protection flag. You can also copy files, and any standard ASCII terminal is supported. There are more than 60 system entry points for program linkage, and up to 16 simultaneous active data control blocks are accommodated. Versions are available for PerCom LFD-400, SWTP MF-68, Smoke Signal BFD-68 disk systems and for the Motorola EXORciser development system. INDEX comes on two diskettes with user manual for \$99.95. Percom Data Company, 318 Barnes, Garland, TX 75042 (Tel: 214-272-3421).

Apple/8080. The Apple-80 software (on cassette) enables any Apple II computer to emulate an 8080. Running on any 16K or more Apple, the software provides single-step, trace and run modes. It also runs 8080 object code and all 8080 registers are displayed on the screen. Trace speed is dynamically variable and can be controlled by paddle-O. The 8080 I/O ports are arranged in a table for ease of assignment. Up to 8 non-destructive breakpoints may be used for easy debugging. Eight 8080 interrupts are available and the 6502 subroutines can be called to enable use of the conventional Apple monitor. The Apple-80 cassette contains two programs. The first is a BASIC program that forms the Apple-80 manual. The second program is the Apple-80 itself. This machine-language program enables the Apple (6502) to emulate the 8080. An 8080 time-of-day clock program is also included for study. \$20 plus \$1.50 shipping and handling. California residents

please add 6% sales tax. Dann McCreary, Box 16435-Y, San Diego, CA 92116.

CP/M Software. An extensive 8080/Z80 disk software line in four formats has just been made available. These include North Star Double Density, Processor Technology Helios II, MITS Altair hard sector and Ohio Scientific C-3 disk systems. Formats previously implemented and still supported include North Star Single Density Micropolis, iCom, SD Systems, Dynabyte DB 8/2 and 8" IBM. Other formats are available on request. A new addition will be available for the Heath H8/H17 system. Running on CP/M, all software is \$145 and includes text editor, assembler, debugger and various other system utilities. Other packages such as FORTRAN, BASIC, COBOL, and CBASIC-2 are available as are payroll, general ledger, accounts payable and receivable, word processing and mail list packages. Lifeboat Associates, 2248 Broadway, New York, NY 10024.

LABEL-BASIC. Designed for the 6800, this language acts as a pre-processor to translate programs written in LABEL-BASIC into programs using a BASIC interpreter or compiler. As an extension of BASIC, it also provides the capability of descriptive line labels and variable names. Because line numbers can be matched, programs built from LABEL-BASIC subroutines can be appended to the main program. This procedure is similar to loading FORTRAN subroutines from a library, although using an editor at source

THE MICROCOMPUTER MART COMPUTER RETAIL STORES

Advertisement

CALIFORNIA

Omega Microcomputers
Quality Personal-Business Systems
Apple 11 - Alpha Micro
3447 Torrance Boulevard
Torrance, CA 91344
(213) 370-1589

Rainbow Computing
Complete Apple 11 Line
9719 Rascada Blvd.
Northridge, CA 91324
(213) 349-5560

FLORIDA

Computer Age, Inc.
Service, Support, Professionalism
At a Very Affordable Price
1308 North Federal Highway
Pompano Beach, FLA 33062
(305) 946-4999

Computer Center of The Palm Beaches
The Microcomputer Specialists
2827 Exchange Court
West Palm Beach, FLA 33409
(305) 689-3233

GEORGIA

Graham Business Computer
Featuring Full Line Ohio Scientific
5725 Buford Highway
Suite 216
Atlanta, GA 30340
(404) 457-8540

MARYLAND

Comm. Center Inc.
Exidy Sorcerer
Call Toll Free
Laurel Plaza - Rt. 198
Laurel, MD 20810
(800) 638-4486

MICHIGAN

Computer Center
Business Systems/Personal Systems
28251 Ford Road
Garden City, MI 48135
(313) 422-2570

The Computer Mart
We Will Not Be Undersold
560 W. 14 Mile Road
Clawson, MI 48017
(313) 288-0040

NEW JERSEY

Computer Mart of New Jersey
The Microcomputer People (R)
501 Route 27
Iselin, NJ 08830
(201) 283-0600

OHIO

Band-Orch, Inc.
Complete Ohio Scientific Line
337 East State Street
Alliance, Ohio 44601
(216) 821-2600

PENNSYLVANIA

Ripley Computers
Affordable Computers For
Business/Churches/Home/Personal
126 N. Main Street
Souderton, PA 18964
(215) 723-1509

Dealers: For information about how to have your store listed in THE MICROCOMPUTER MART, please contact:
POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016 • (212) 725-3568.



Are You SERIOUS About Having FUN With Your Computer?

Creative Computing Magazine

Creative Computing is Number 1 in applications and software. Things like: text editing, graphics, communications, artificial intelligence, simulations, data base and file systems, music synthesis, analog control. Complete programs with sample runs. Programming techniques: sort algorithms, file structures, shuffling, etc. Coverage of electronic and video games and other related consumer electronics products, too.

Just getting started? Then turn to our technology programs, and problem solving pages. No-nonsense book reviews, too. Even some fiction and foolishness.

Subscriptions: 1 year \$15, 3 years \$40. Foreign, add \$9/year surface postage, \$26/year air.

Basic Computer Games



Edited by David Ahl, this book contains 101 imaginative and challenging games — Black-Jack, Super Star Trek, Horse Race, lunar lander. Play the stock market. Write poetry. Draw pictures.

All programs are complete with listing sample run and description. 192 pages soft-bound. [6C] \$7.50.

More Basic Computer Games

Contains 84 fascinating and entertaining games for solo and group play — evade a man-eating rabbit, crack a safe, navigate in deep space. 192 pages softbound. [6C2] \$7.50.

Adventure

Adventure is an astonishing new innovative game for your TRS-80, Sorcerer or PET. Search for hidden treasure while avoiding exotic wild animals.

For 16K Level II TRS-80 and 16K Sorcerer: (1) Adventureland, (2) Pirate Adventure, (3) Mission Impossible, (4) Voodoo Castle, (5) The Count. (1) and (2) for 24K PET too. \$14.95 per tape.

Free Software Catalog

Our software catalog offers over 200 recreational, educational and technical programs for your TRS-80, Apple, PET, Sorcerer, SOL-20, Challenger and CP/M systems. Write for your free copy today!

To Order...

Send order and payment to **Creative Computing**, P.O. Box 789-M, Morristown, NJ 07960. Add \$1.00 shipping and handling per order (foreign, \$2.50) N.J. residents add 5% sales tax. Visa, MasterCard and American Express orders welcome. For faster service, call in your bank card order toll free to: 800-631-8112. (In NJ, call (201) 540-0445).

creative computing

CIRCLE NO. 62 ON FREE INFORMATION CARD

code level is not required. The language is available for 6800-based Chieftain computers and SSB disk systems and costs \$59.95. Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village, CA 91361 (Tel: 213-889-9340).

Apple Stuff. A catalog of 50 Apple II programs includes business accounting, accounts receivable, inventory, BASIC teaching and other special business programs. The applications support disk or tape systems and are available in both Apple BASICs. Charles Mann and Associates, Micro Software Division, 1926 South Veteran Ave., Los Angeles, CA 90025 (Tel: 213-473-0244).

TRS-80 Mail List. MAILROOM PLUS is a record keeping and mail-list program written for the TRS-80. Record size can be from 1 to 255 characters, and there is no need to specify field dimensions. It can sort 500 records by category number, zip code, or last name. A standard TRS-80 diskette (with DOS) will hold approximately 2000 records. The program will selectively search, display or print records. Print option will output in either tabular form or mailing labels. Any part of a record can be used as a search code. Thus, records can be displayed or printed by states, zip codes, names, cities or categories. Large files can be selectively separated and saved as smaller files by state or any portion of the zip code. Small files can be merged to create one large file. The program requires 32K of memory and one or more disk drives. The program is supplied on diskette for \$49.95. The Peripheral People, Box 524, Mercer Island, WA 98040.

6800 Programs. A considerable number of 6800-based software packages including many games, text editors, assemblers and disassemblers, and de-bug programs are among the many offered by catalog. Technical System Consultants, Inc., Box 2574, W. Lafayette, IN 47906 (Tel: 317-463-2502).

TRS-80 Programs. A very complete line of TRS-80 programs with a broad variety of games, financial programs, chess, languages, statistics, ham radio plus a listing of hardware accessories. Catalog available from TRS-80 Software Exchange, 17 Briar Cliff Drive, Milford, NH 03055 (Tel: 603-673-5144).

Apple Assembler/Text Editor. The ASM/ED complements the facilities provided by the Apple monitor routines. It allows you to enter assembly language programs, edit them and assemble them into memory. The editor is line-numbered and allows adding new lines, deleting lines, resequencing line numbers, text listing, locating a line having a specific string, and storing the edited text on tape or disk. The assembler is one-pass (mods are provided for two-pass operation) that accepts free-format input containing labels up to six characters, the complete 6502 opcode set, and a comment field. Multiple source files may be assembled using a common symbol table. The assembler operates on a memory resident source file and produces memory resident object code. The complete package is provided on Apple cassette and requires 16K of RAM. \$29.95. In-

WIRE CIRCUITS FASTER
WITH SOLDER-THRU PENCIL WIRING
VECTOR P178-1

\$7.95 NET

NEW IMPROVED TOOL

- Makes solder wrapped connections 3 times faster than usual way.
- Quick-melt insulation for clean, fast solder joints with 750°F. iron.
- Fast snap-in spools.
- Easy threading & finger controlled tension & advance.
- Slim, light, comfortable tip angle.

NEW! better

EVERYONE NEEDS ONE!

VECTOR ELECTRONIC COMPANY, Inc.
12460 Gladstone Av., Sylmar, CA 91342
phone (213) 365-9661
twx 910-496-1539

If unavailable locally, factory order. Add \$2.00 shipping and handling charge. California residents add 6% sales tax.

CIRCLE NO. 57 ON FREE INFORMATION CARD

Save on Calculators

HEWLETT-PACKARD

Model	Your Cost
HP-41C Scient	\$244.95
Card Reader/41C	159.95
Printer/41C	289.95
HP-34C Scient	124.95
HP-38C Bus.	124.95
HP-38E Bus.	99.95
HP-33C Scient	99.95
HP-33E Scient	74.95
HP-37E Bus. prog	62.95
HP-32E Adv. Scient	59.95
HP-31E Scient	42.95
HP-67 Scient Prog	299.95
HP-97 Scient Print	594.95
HP-29C Scient c/m	139.95
HP-10 HH Print	139.95
HP-92 Bus. Print	399.95

We carry an enormous stock of HP accessories. All units come complete. One year guarantee by HP.

TEXAS INSTRUMENTS

TI-59	\$209.95	TI-35	23.95	Speak & Spell	54.95
TI-PC100C	148.95	TI-50A0	89.95	Date Card	23.95
TI-50C	94.95	TI-5100	42.95	Business Card	35.95
TI-57	48.95	TI-5200	Call us	MBA	58.95
TI-55	35.95	TI-5225	Call us	TI-5025	79.95
TI-50	35.95	TI-5221	Call us	TI-5015	62.95
TI-25	29.95	TI-5230	Call us		

Huge inventory of TI accessories on hand at all times, discount prices. All units come complete, fully guaranteed by Texas Instruments.

SPECIALS

SEIKO SPECIALS		Dual time zone dig. SS	89.95
320 Seiko watches to choose from		Chronograph dig. SS	119.95
Cartier type "Tank" goldtone	187.95	Alarm/Chronograph dig. SS	159.95
men		Solar Alarm/Chrono SS	169.95
Cartier type "Tank" goldtone	187.95	Memory Bank Calendar SS	159.95
women		Alarm dig. SS Quartz	129.95
Large selection of ladies, men, analog digital, thin, ultra thin, divers, flyers, all kinds		Multi Alarm Goldtone	199.95
		Goldtone available at higher prices.	
Sony TV's all models	Call us	RCA Select VCT 201 4 hrs auto s/o	799.95
Benetax SL8600	889.95	Craig Translator and modules	Call us
RCA Selectvision VCT400X prog	999.95	Dictating equip, all kinds	Call us

Prices are f.o.b. LA. Add \$4.95 for shipping handhold calcs in USA. CA residents add 6% sales tax. We will beat any advertised deal if the competition has the goods on hand. Goods subject to availability. Ask for our famous catalog. Call Monday thru Saturday, 7AM to 6PM. Outside CA, toll-free (800) 421-8045. In CA (213) 381-3911. VISA and MASTERCARD CARDS accepted.

OLYMPIC SALES COMPANY, INC.
216 South Oxford Ave. • P.O. Box 74545
Los Angeles, CA 90004 • (213) 381-3911 • Telex 67-3477

CIRCLE NO. 43 ON FREE INFORMATION CARD

cludes a 60-page manual and includes shipping within the U.S. Add \$4 for first-class shipping outside the U.S. ARESCO, Box 1142, Columbia, MD 21044, (Tel: 301-730-5186). This company also publishes the Rainbow, an Apple II newsletter.

Macro Assembler/Text Editor. Written for the 6502-based PET, APPLE-II and SYM systems, this software package is written in assembly language and occupies 8K of memory starting at 2000 hex. It provides 27 commands, 20 pseudo ops and features macro and conditional assembly support, extensive text editing commands including automatic line numbering, string search and replace, tape load/save and append commands, vectors for disc system interface, free format assembler source input, source syntax similar to MOS Technology specs, and many more functions. User manual and either PET, Apple II, or SYM (HS) cassette (please specify) available for \$35 plus \$2 shipping/handling. C. W. Moser, 3239 Linda Dr., Winston-Salem, NC 27106.

6809 Cross Assembler. Designed to operate under the FLEX disk operating system, this cross-assembler is fully compatible with both 6800 and 6809 mnemonics. Existing 6800 source listings can be directly reassembled to produce executable 6809 object code. It is also 6801 compatible. All standard mnemonics and directives are supported, as well as warning messages which may be enabled or suppressed. Available in binary form on FLEX 1.0 (8") or FLEX 2.0 (5 1/4") diskette. Manual and disk available for \$100 from Technical Systems Consultants, Inc., Box 2574, West Lafayette, IN 47906 (Tel: 317-463-2502).

PET Software. Series-One is a collection of 25 programs for the 8K PET. There are 16 games including Space Wars, Motorcycle Jump, Saucer Attack, Ping Pong, etc., and 9 general programs, including Mortgage Loan, Perpetual Calendar, Elementary Math, and Savings Account. \$24.95. ADP Systems, 95 West 100 South, Logan, UT 84321 (Tel: 801-752-2770).

PolyMorphic Mailist. Designed for a 2-drive, 32K System 8813, this program allows the user to organize information according to the requirements of the specific mail list. The entry format may be organized to store specific data associated with the mailing name and address, which may never appear on the actual mailing label. Not only does the user organize the entry format, he also indicates by field which information is to be printed in what order. This allows letter merge. The Mailist can also be used as a general data base organizer in which the user defines a format he needs. PolyMorphic Systems, 460 Ward Drive, Santa Barbara, CA 93111 (Tel: 805-967-0468).

TRS-80 Electric Secretary. Written for the TRS-80 single or multiple disk systems, and a minimum of 32K or memory, this word processing program features a word hyphenating dictionary. Long words at the end of a line need not produce large gaps in the text. When this might occur, the program asks the user to hyphenate the word which is then stored in the dictionary with the correct

hyphenation points. The text is then printed, hyphenated and justified. File coupling permits lengthy text without memory overload, and the program is well suited for form letter generation. Available on a formatted disc at \$75. Upper/lower case conversion information is free upon request. The Peripheral People, Box 524, Mercer Island, WA 98040.

PET Software. Four new PET programs, each costing \$24.95, are now available: ENTRY used as a general-purpose data entry program has user-definable entry format and may be used for a mail list, daily journal, general ledger, record keeping, etc.; PROCESS which is a general-purpose data process program includes SORT, EDIT, DELETE, INSERT and MACRO and is useful for merging large amounts of data from different input sources; DCE TEXT EDITOR/FORMATTER features full-screen editing including cursor movements with repeatable cursor scrolling of pages up and down, and user definable output margins and justification. Programs are written in machine language with 4K bytes free for user text data; and INVENTORY that includes item number, description, quantity on hand, reorder limit and prices. It generates inventory and low inventory reports, and can handle up to 60 items on an 8K PET. Home Computer Centre, 6101 Yonge St., Willowdale, Ontario, Canada M2M 3W2, Canada (Tel: 416-222-1165).

Program Aids for Apple. Programmers Aid #1 package is a ROM-based library of routines whose capabilities include high-resolution graphics, program renumbering and linking, tape verification, tone generation, RAM testing and machine-language relocation. It is designed for use with the Apple II integer BASIC. The high-resolution graphics allow drawing from 53,000 screen locations in one of four colors (black, white, green or violet). Simple BASIC commands can create figure size, orientation and color. Additional commands plot points, clear screen and create background color. The Appleodeon portion uses a note table stored in memory and covers five timbres spanning four octaves. The package costs \$50. Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014, or your local computer store.

PET Workbooks. "Getting Started with Your PET" (WB-1, \$3.95) covers PET BASIC, calculator and program modes, data input/output, data representation, and cassette storage. "PET String and Array Handling" (WB-2, \$3.95) covers string and substring search, concatenation, replacement and manipulation, limitations and features of arrays, subscripted variables and parallel sequences. "PET Graphics" (WB-3, \$4.95) covers cursor control and special graphics to create plots, histograms and sketches. "Pet Cassette I/O" (WB-4, \$4.95) covers the cassette I/O system. "Miscellaneous PET Features" (WB-5, \$3.95) covers clock, random number generation, upper- and lower-case characters, saving memory, etc. "PET Control and Logic" (WB-6, \$3.95) covers testing and branching, subroutines, logical operations. Binary-to-decimal and decimal-to-binary programs are used to demonstrate logical operations. All six books for \$19.95 plus \$1.50 shipping/handling. Total Information Services, Box 921, Los Alamos, NM 87544.

ASSEMBLY LANGUAGE

Programming Primers for the most popular Microcomputers

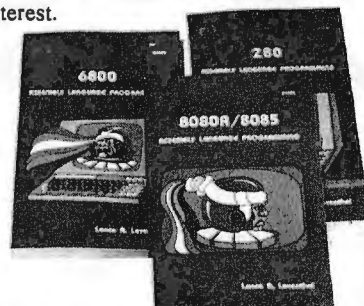
Z80 • 6800

8080A/8085

COMING 6809**

NEW
6502

These Assembly Language Programming books view assembly language as a means of programming a microcomputer system. Each book explains assembly language programming, describes the functions of assemblers and assembly instructions, and discusses basic software development concepts. A special section on structured programming rounds out the discussion of programming examples, which range from simple memory load loops to complete rudimentary design projects. Each book includes comprehensive coverage of the particular assembly language, and presents a large number of fully debugged, practical programming examples written in the language of interest.



Tables of Contents: Introduction to Assembly Language Programming; Assemblers; The Assembly Language Instruction Set; Simple Programs; Simple Program Loops; Character Coded Data; Code Conversion; Arithmetic Problems; Tables and Lists; Subroutines; Input/Output; Interrupts; Problem Definition and Program Design; Debugging and Testing; Documentation and Redesign; Sample Projects.

*6502 ALP will be available Nov. 1979. Orders currently being accepted.

**6809 ALP publication, Spring 1980. Please check box below to be notified of its availability.

Order Form: Please send me the following Assembly Language Programming books:

	Quantity	Price	Amount
8080A/8085 ALP		\$9.50	
Z80 ALP		\$9.50	
6800 ALP		\$9.50	
6502 ALP		\$9.50	
Tax — Calif. residents only		Tax	
Shipping—allow 4 weeks		Shipping	
45¢ per book USA,			
\$4.00 foreign		TOTAL	

Name: _____
Address: _____
City: _____ State: _____
Zip: _____ Phone: _____

☐ Please notify me when 6809 ALP is available.

OSBORNE/McGraw-Hill, Inc.
630 Bancroft Way, Dept. A6
Berkeley, CA 94710

For faster shipment or credit card, phone (415) 548-2895

name _____

address _____

city _____ state _____

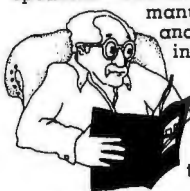
zip _____

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

MAIL THIS COUPON AND WE'LL SEND YOU THE BEST SPEAKER CATALOG YOU EVER READ!

No kidding. Speakerlab's catalog took longer to write than some of our competitors have been in business. In fact, we created an industry by "building great kits so you can afford great speakers." Our catalog is an invaluable



manual of speaker function and design. And, it will introduce you to the finest speaker kits made anywhere...with the strongest money-back guarantee. Find out for yourself...FREE. FREE, that is. Mail the coupon now.



Dept. 10-PE, 735 N. Northlake Way
Seattle, WA 98103

SAVE!

MONEY • TIME • FREIGHT

QUALITY STEREO EQUIPMENT
AT LOWEST PRICES.

YOUR REQUEST FOR QUOTA-
TION RETURNED SAME DAY.

FACTORY SEALED CARTONS—
GUARANTEED AND INSURED.

SAVE ON NAME BRANDS LIKE:

PIONEER	SANSUI
KENWOOD	DYNACO
SHURE	SONY
MARANTZ	KOSS

AND MORE THAN 50 OTHERS
BUY THE MODERN WAY
BY MAIL—FROM

illinois audio

BANK CARDS ACCEPTED

12 East Delaware
Chicago, Illinois 60611
312-664-0020

CIRCLE NO. 27 ON FREE INFORMATION CARD

Solar model CBB capacitor analyzer. Need schematic and operation instructions. Guy Edwards, 104 Hancock, San Francisco, CA 94114.

Lloyds model Tj1 stereo receiver and **Emud** model T7 AM/FM shortwave receiver. Schematic needed. Andy Karpen, 2519 Manning St., Ambridge, PA 15003.

Mathatron power log. Need instruction, operation manual and schematics. W. Kolb, 4610 7th Rd., N., Arlington, VA 22203.

Tektronix model 512 oscilloscope. Need manual and any available information on calibration. Wayne Torrey, 8354 Thunderhead Dr., Boulder, CO 80302.

DeVry Technical Institute model 1-1S oscilloscope. Need schematics and operations manual. Andrew J. Sprull, 624 Lee St., Port Allen, LA 70767.

Delta Graph model EQ-10 octave-band equalizer. Need assembly manual. Edward J. Bawolek, 6912 Young Court, Woodridge, IL 60515.

Kintel Electronic model 204A galvanometer. Need schematic and operations manual. Robb Craig, 16650 Morrison St., Encino, CA 91436.

Unitrex model 14PPMD printing display calculator. Schematic and operation manual needed. Dave Pressman, 1237 Chestnut St., San Francisco, CA 94109.

Western Electric power supply. Need tubes 313C-2A3 and operation manual and schematic. John C. Leonard, R.R.#1, Box 131, Yarmouth, ME 04096.

Sansui ZC-94 CD-4 super demodulator. Need service manual, parts list and test record. **JVC** CD-4 test record RG 1256, RG 1257 for setting internal variable resistors of a CD-4 demodulator. D.S. Battershill, 5208 Vallance Cres. NW, Calgary, Alberta T3A 0T6 Can.

Grundig model #2083-115 multisonic receiver. Need any service manuals that can be provided. Ken Long, GND Electronics, NAS Miramar, San Diego, CA 92145.

Knight K6-625 VTVM. Need schematic or any available information. Jim Miller, 70 New St., Mercerville, NJ 08619.

Jackson model 648-S tube tester, serial #NR 27341. Need schematic, manual and source of current tube chart. Avery Comarow, 524-B Springvale Rd., Great Falls, VA 22066.

Tektronix model 533A oscilloscope. Need manual and schematic. Ed Juzumas, 88-57 75th St., Woodhaven, NY 11421.

Triplett model 3432-A signal generator. Need operations manual. R. Maslow, 100 Richard St., West Haven, CT 06516.

Mast Development Co., model 725-3C serial # GT 393 strip-chart recorder. Need operating and repair manuals and schematic. Grant Fair, RR. #1, Pickering, Ontario L1V 2P8, Can.

Dumont type 322 serial 1A10 beam cathode-ray oscillograph. Need any information available. Robert Hayes, 1061 Rio Ave., Jensen Beach, FL 33457.

Hallcrafters SX-62 shortwave radio. Need manual, schematic and any other information. Steve Lindberg, 12900 S.E. Division #6, Portland, OR 97216.

Hallcrafters SX-28. Need parts. **Johnson Viking** 6N2 transmitter and **Beckman Instruments Co.**, FR-67 frequency meter. Schematics needed. Harold D. Donaldson, WB6SKV, 8850 Phoenix Avenue, Fair Oaks, CA 95628.

BSR TD 1020 7" tape deck. Need owner's manual and schematics. John E. Jurus, 36 Pembroke Dr., Yonkers, NY 10710.

Precision Apparatus signal generator series #—200-C M1179. Need schematic and operating instructions. Edward H. West, 57 Eastlake, Tuscaloosa, AL 35405.

Ardco Electronics model BC-610 or BC-669 transmitter. Need any information available. Ray Nanney, R1, Box 658, Hardin, KY 42048.

Sanwa Electric Instrument Co., Ltd., model 380-C multimeter manufactured in 1964. Need circuit diagram or address of company. L.R. Hillman, Box 635, Littleton, NC 27850.

Philco model 40-180 code 121 console radio. Need schematic and service manual. R.J. Klaus, 1345 Highland Dr., Carroll, IA 51401.

RCA Victor model 3-BX-671 AM-SW portable. Need schematics and owner's manual. Allen Black, Box 386, N. Myrtle Beach, SC 29582.

Triplett model 3432-A signal generator. Need operating manual. R. Maslow, 100 Richard St., West Haven, CT 06516.

RCA model CTC-5 color TV. Need parts list. **Philco** model 40-180 receiver. Need technical data. Richard Bozeman, 6006 N. Hale Ave., Tampa, FL 33614.

Akai X-2000 cassette open-reel recorder. Need manual and electronic diagram. Fermin Herena, Eulogio Parra #6, Tepic, Nayarit, Mexico.

Marconiphone model T26A radio. Need service manual. Edward H. Joseph, 20701 Reef Lane, Huntington Beach, CA 92646.

Delta Graph model EQ10SP audio graphic equalizer. Need assembly manual. Edward J. Bawolek, 6912 Young Court, Woodridge, IL 60515.

Webcor model #375638 tape recorder. Need schematic. Bob Ausman, 1110 Dary Rd., Havertown, PA 19083.

Lloyds model #D614-07A hi-fi. Need schematic. Don Gross, Rd. #1, Cameron Mills, NY 14820.

Marantz model #26 receiver. Need circuit diagram and service manual. Carlos Peres da Costa, Av. Rui Barbosa 471, Gracas, Recife PE 50.000 Brazil.

Hewlett-Packard model 400H ac voltmeter. Need operating and service manual. Jacques Blais, 1698 9e Ave., Charny, Que. G6W 4H2.

Philco model S8202 oscilloscope. Need schematic. L. Truetken, 10601 Dunkeld Circle, St. Louis, MO 63137.

Sycor, Inc., model 303 key cassette. Need schematics, operating manual or instructions. Jim Cook, 11451 Olson Dr., Garden Grove, CA 92641.

RCA model WO-56A oscilloscope. Need calibration and operation manuals. Bob Brandel, Rosa-Hulman Institute of Technology, Box 927, 5500 Wabash, Terre Haute, IN 47803.

Denon model MX-1010 AM/FM record player. Need schematic. M. DaCosta, 5675 No. 8th, Fresno, CA 93710.

Hallcrafters model S-120 receiver. Need schematic, operations manual and alignment data. Shawn Sterling, 12319 Bank Box Pl., Dallas, TX 75234.

Stark model 9-11 tube tester. Schematic and operations manual needed. Russell Campbell, Box 141, Thessalon, Ontario, Can. P0R 1L0.

Solar model CE capacitor tester. Need operations manual. D. G. Daube, 912 Lebanon Ave., Castle Shannon, PA 15234.

Starkit model 5A-2 AM radio. Need operations manual. Fred R. Woepel, Box 1653, Edson, Alberta, Can. T0E 0P0.

Telequipment model S 51A oscilloscope. Need schematic and owners manual. Gianni Restaino, 5811 South Moody, Chicago, IL 60638.

BP Radio Equipment type CFN-46ADT rf to lf converter. Need any available information. James O. Dickinson, W4LLF, 1408 Monmouth Court West, Richmond, VA 23233.

Bullet Electronics model PS-14 power supply. Need schematics and parts list. David G. Mason, 66 Mint Circle, Middleburg, FL 32066.

AN/USM-32 oscilloscope. Need schematics, service manuals or USAF technical order 33A1-13-52-1. Wayne A. Murningham, 3101 Portage Blvd, Apt. 6, Fort Wayne, IN 46804.

Instrument Electronics model 53-1 VTVM. Need instruction manual, schematic or any available information. J. Dunlap, 325 N. Ridgeland Ave., Oak Park, IL 60302.

Precision model #400 generator. Need operation manual. Ken Miller, 10027 Calvin St., Pittsburgh, PA 15235.



YOU'RE READING POPULAR ELECTRONICS.

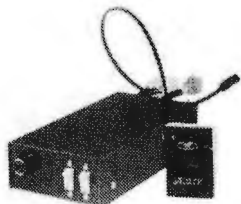
That already says a lot about you. That you're fascinated by the diversity of electronics. Everything from microcomputers to audio, from construction projects to ham radio. Who knows what area of electronics will catch your interest next? That's why you read P.E. To keep in touch with all that's new and best in the many worlds of consumer electronics.

Popular Electronics

World's largest-selling electronics magazine

CORDLESS CONVENIENCE

THE REMOTE CONTROL STARTER FOR YOUR CAR AND THE WIRELESS TELEPHONES ARE JUST TWO OF OUR PRODUCTS THAT WILL HELP YOU ACHIEVE THIS.

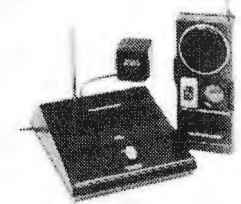


REMOTE STARTER:

IT IS THE ULTIMATE IN MOTORING CONVENIENCE. THE TRANSMITTER IS THE SIZE OF A MATCH BOX 1.7" x 2.5 x .7". THE SMALLEST IN THE WORLD. NO MORE WAITING FOR A COLD CAR TO WARM UP, OR A BOILING ONE TO COOL OFF. JUST START IT FROM YOUR HOME OR OFFICE AND SIT INTO A COMFORTABLE ENVIRONMENT WHEN YOU ARE READY TO DRIVE AWAY. DON'T WORRY. NO ONE ELSE CAN DO THE SAME BECAUSE IF YOUR CAR IS PUT INTO GEAR WITHOUT A KEY THE ENGINE WILL AUTOMATICALLY STOP TO PREVENT ACCIDENT OR THEFT. ORDER YOURS NOW FOR ONLY \$249 (CANADA \$299) WITH 10 DAY MONEY BACK GUARANTEE.

DEALER INQUIRIES INVITED

THE CORDLESS PHONE



THE ULTIMATE IN PHONE CONVENIENCE. NO MORE SCRAMBLING FOR THE PHONE WHEN IT RINGS. YOU CAN ANSWER YOUR PHONE UP TO 700'. THIS MEANS YOU CAN EVEN GO OVER TO THE NEIGHBORS OR GO SHOPPING AROUND THE CORNER WITHOUT HAVING TO STICK TO THE PHONE WAITING FOR AN IMPORTANT CALL. THIS UNIT IS ALSO AN IDEAL DETERRENT FOR WOULD BE THIEVES. THEY ALWAYS CALL TO CHECK IF YOU ARE AT HOME. WITH OUR CORDLESS PHONE YOUR NEIGHBORS CAN ANSWER. MAKING IT SEEM LIKE SOMEONE IS OCCUPYING YOUR HOUSE. IN THE OFFICE OR PLANT. NO MORE RUNNING TO THE NEAREST PHONE TO FIND OUT YOU DON'T EVEN WANT TO TALK TO THE CALLER. YOUR SECRETARY CAN PRESS THE INTERCOM BUTTON AND TELL YOU WHO'S CALLING (WITHOUT THE PARTY HEARING, BECAUSE THEY ARE ON HOLD). ORDER YOURS NOW FOR ONLY \$99 (CANADA \$129) WITH 10 DAY MONEY BACK GUARANTEE WITH TOUCH DIALER \$249 (CANADA \$299) TOTALLY MOBILE PHONE. USABLE THROUGHOUT NORTH AMERICA \$3000.

PLEASE SEND CHECKS, MONEY ORDERS, BANKAMERICARD (VISA) OR MASTER CHARGE TO TEKNIKN DEPT. PE10
1333-54th ST. BROOKLYN, N.Y. 11219
CANADA - 3018 BATHURST ST., TORONTO ONTARIO M6B 3B6

N.Y., ONT. RESIDENTS ADD SALES TAX.

CIRCLE NO. 55 ON FREE INFORMATION CARD

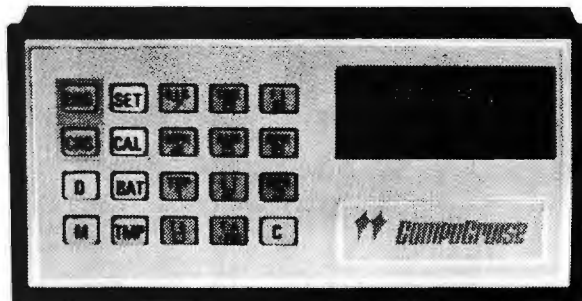
English Broadcasts Audible in No. America

by Glenn Hauser

TIME ¹ COT	TIME UTC/GMT	STATION	QUAL. ²	FREQUENCIES, kHz ³
4:00-4:15 a.m.	0900-0915	BBC	A	11955, 9640, 9510, 6195
4:00-4:15 a.m.	0900-0915	R. Japan ⁴	B	9505
4:00-5:30 a.m.	0900-1030	R. Australia	B	9670
4:15-6:00 a.m.	0915-1100	BBC	B	17790, 17695
4:30-5:30 a.m.	0930-1030	V. of Germany	B	17780
5:00-5:05 a.m.	1000-1005	UN Radio	A	9565, 5955 (Tue-Sat.)
5:00-5:30 a.m.	1000-1030	R. Japan	B	9505
5:00-5:30 a.m.	1000-1030	R. Korea	C	11725, 9580 (frequent changes)
5:00-5:30 a.m.	1000-1030	V. of Vietnam	C	12035, 10040, 9840
5:00-fade out	1000-	R. Australia	B	5995
5:00-6:00 a.m.	1000-1100	AFRTS	A	6030
5:00-8:00 a.m.	1000-1300	R. Moscow (via Cuba)	A	9600
5:00-11:02 a.m.	1000-1602	ABC, Perth	B	9610
5:30-6:30 a.m.	1030-1130	Sri Lanka Br. Corp.	C	17850, 15120, 11835 (not all Eng.)
5:30 a.m.-6:00 p.m.	1030-2300	CBC Northern Service	B	9625 6065, (not all Eng.)
5:55-6:55 a.m.	1055-1155	R. Thailand	C	11905, 9655
6:00-6:15 a.m.	1100-1115	R. Japan	B	9505
6:00-6:56 a.m.	1100-1156	R. RSA	C	25790, 21535
6:00-7:45 a.m.	1100-1245	TWR-Bonaire	A	15225 (Sat-1330, Sun-1415)
6:00-7:50 a.m.	1100-1250	R. Pyongyang	C	9977
6:00-8:00 a.m.	1100-1300	R. Australia	A	9580
6:00-8:30 a.m.	1100-1330	BBC	A-B	25650, 21710, 21660, 21550, (11775, 1100-1130 + 1300-1330 only) 11750, 9510, 6195
6:00-9:00 a.m.	1100-1400	4VEH, Haiti	B	11835, 9770
6:00-9:00 a.m.	1100-1400	AFRTS	A	15430, 15330, 11805, 9700
6:00-9:00 a.m.	1100-1400	VOA	A	11715, 9730, 9565, 5955
6:30-6:45 a.m.	1130-1145	R.R.I. Yogyakarta	C	5046
7:00-7:15 a.m.	1200-1215	Vatican R.	B	21485
7:00-7:15 a.m.	1200-1215	R. Japan	B	9505
7:00-7:30 a.m.	1200-1230	Kol Israel	C	25625, 21495, 17685, 17565
7:00-7:30 a.m.	1200-1230	R. Tashkent	C	15460, 15125, 11925, 11730
7:00-7:45 a.m.	1200-1245	V. of Germany	B	21600, 17875, 17765, 15410
7:00-7:45 a.m.	1200-1245	R. Berlin International	C	21540, 21465, 17700, 15165
7:00-7:55 a.m.	1200-1255	R. Peking	C	11685
7:00-8:00 a.m.	1200-1300	HCJB, Ecuador	A	15115, 11740
7:15-7:30 a.m.	1215-1230	V. of Greece	B	21655, 17785, 11730
7:20-7:50 a.m.	1220-1250	R. Ulan Bator, Mongolia	O	12070, 9575 (not Sun)
7:30-7:55 a.m.	1230-1255	Austrian R.	C	17860 (frequent changes)
7:30-7:55 a.m.	1230-1255	R. Tirana	C	11965, 9515
7:30-8:00 a.m.	1230-1300	R. Sweden	C	21690, 21635
7:30-8:00 a.m.	1230-1300	BBC (English by radio)	B	21695
8:00-8:15 a.m.	1300-1315	R. Japan	B	9505
8:00-8:30 a.m.	1300-1330	R. Finland	C	15400
8:00-9:00 a.m.	1300-1400	R. Australia	B	9770
8:00-10:50 a.m.	1300-1550	R. RSA	B	25790, 21535, 15220
8:00-9:30 a.m.	1300-1430	HCJB, Ecuador	B	17890, 15115, 11740
8:00 a.m.-6:00 p.m.	1300-2300	CBC Northern Service	B-C	11720, 9625 (not all English)
8:15-8:45 a.m.	1315-1345	Swiss R. International	C	21570, 21545-SSB, 21520
8:30-8:30 a.m.	1330-1430	R. Finland	C	15400 (Sun. only)
8:30-10:00 a.m.	1330-1500	All India R.	C	15335, 11810
8:30-11:00 a.m.	1330-1600	BBC	B-C	25650, 21710, 21680, 21550, 15400 (from 1430), 15070
8:30 a.m.-5:00 p.m.	1330-2200	R. Moscow (via Cuba)	A	11840
9:00-9:30 a.m.	1400-1430	R. Japan	B	9505
9:00-9:30 a.m.	1400-1430	R. Sweden	B	21615
9:00-9:30 a.m.	1400-1430	R. Norway	B	21730, 17840 (Sun only)
9:00-9:30 a.m.	1400-1430	V. Rev. Party, N. Korea	D	4557, 4109
9:00-9:30 a.m.	1400-1430	R. Tashkent	C	15460, 15125, 11925, 11730
9:00-9:45 a.m.	1400-1445	R. Berlin International	C	21540, 21465, 17700
9:00-10:00 a.m.	1400-1500	VOA	A	11715, 9565
9:00-10:00 a.m.	1400-1500	V. of Indonesia	C	15200, 11789
9:00-11:00 a.m.	1400-1600	AFRTS	A	15430, 15330, 11805, 9770
9:00 a.m.-12:30 p.m.	1400-1730	R. Australia	B	11880, 9770
9:30-10:00 a.m.	1430-1500	R. Finland	B	15400, 17785
9:30-10:25 a.m.	1430-1525	R. Nederland	B	21480, 17855
9:30-11:00 a.m.	1430-1600	HCJB, Ecuador	A	17890, 15115
9:30-11:00 a.m.	1430-1600	Burma Br. Ser.	D	5985, 5040
9:30 a.m.-5:00 p.m.	1430-2200	UN Radio	A	21670, 15410 (also French; when in session)
10:00-10:15 a.m.	1500-1515	R. Japan	C	9505
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9560
10:00-11:00 a.m.	1500-1600	BBC	B	17830, 11775 (Sat, Sun)
10:15-10:30 a.m.	1515-1530	V. of Greece	B	21455, 17830, 11730 (last two, not Tues.)
10:30-11:00 a.m.	1530-1600	R. Afghanistan	D	4775
10:30-11:00 a.m.	1530-1600	R. Yugoslavia	C	15300, 15240
10:30-11:00 a.m.	1530-1600	Swiss R. International	B	21570
10:30-11:15 a.m.	1530-1615	NSB, Tokyo	C	9595, 6055 (exc Sun)
10:30-11:30 a.m.	1530-1630	V. of Vietnam	C	15012, 14990, 10040
10:45-11:00 a.m.	1545-1600	R. Canada International	A	21695, 17820, 15325 (Mon-Fri only)

Car Computer Breakthrough

This amazing new, yet thoroughly tested, car computer performs 44 different functions as simply as touching a button; and mounts easily in or on the dashboard of your car.



The command module is 3" x 6" x 1-3/16". Backlighting keyboard and bright 5-digit blue florescent display make night operation easy.

Our evaluating team looks at hundreds of new products each year and on this one they told us: "It's the most amazing product we've ever seen!" We agree with the engineers... the Compucruise is an amazing on-board computer that gives you up to the minute information. Easy to operate and easier still to install with 44 functions at your fingertips. The Compucruise does so much we had to put the features in categories. It's truly amazing.

FUEL MANAGEMENT: The most important of the 44 functions available with Compucruise is its ability to give you up to the moment fuel management information. With push-button ease you get miles per gallon, gallons per hour and average fuel use for the entire trip. The "distance to empty" function lets you know exactly how many miles you will be able to travel on the fuel presently in your tank. Imagine knowing exactly how far you can go on the fuel you have. As an informational feature you can also know distance traveled and fuel used since last fill-up or amount of fuel left in tank. With Compucruise you will know the most efficient speed at which to travel, the most efficient brand and grade of fuel for your car, the effect of various brands, types and pressures of tire on fuel efficiency and when tune-ups are needed.

TIME: With your Compucruise installed, you have all the regular time functions of a quartz digital clock accurate to within 30 seconds per month. A built-in alarm can be set for up to 24 hours in advance. Did you ever wonder if the short cut saves time or fuel? By merging distance, time and fuel use information, Compucruise can make your automobile trips (whether to the office or cross country) much more enjoyable. That's right, you can now plan your trip right to the minute based on rate of speed and distance to be traveled. The Compucruise time feature also gives you the length of time that you can travel on the fuel presently in your tank, time spent on the trip thus far and time to arrival at your destination. There's also an elapsed time function that you reset at the touch of a button.

SPEED: Since speed is nothing more than a function of distance and time, Compucruise offers accurate speed maintenance and control. Simply calibrate it by driving a known distance (between mile markers on a federal highway for instance). You will now

have the most accurate speedometer available flashing your speed digitally and automatically taking into consideration tire size and pressure. With a touch of a button you can observe your average speed on the trip.

CRUISE CONTROL: With the cruise control feature you can take speed maintenance one step further. Just set the computer to engage at a specific speed or allow it to engage at your present speed. If you wish to increase your speed, simply touch the "cruise" button and your speed will increase in increments of two miles per hour. A touch of the brake takes you out of cruise. To re-engage, simply push the "cruise" button again and the car will return to the pre-programmed speed.

TEMPERATURE: Two temperature sensors come with this unit. Mount one inside the car and one outside and you will be able to read either temperature in degrees, Fahrenheit or Celsius. Or mount one sensor inside the radiator and monitor coolant temperature and you will have the most accurate information available to prevent overheating.

HOW IT WORKS

Space age technology makes it possible to install Compucruise as easily as any traditional cruise control device. A strip of four magnets installed around the drive shaft together with a magnetic sensor switch supplies information to the computer for speed and distance functions. The fuel sensor is easily installed into the rubber fuel line. All adaptors and hose fittings are supplied. Vacuum sensors are mounted close to the carburetor for the optional cruise control feature. Temperature sensors can be installed wherever you wish to monitor temperature. Simply hook up to the car's 12 volt battery and you're ready to go...OR...easiest of all, take Compucruise to any service station and have the mechanic install it.

NOTE: Compucruise will not work on fuel injection or diesel engines. A model for diesel and fuel injection engines will be in production later this year.

THE 44 FUNCTIONS

... time of day - elapsed time - stop watch - trip driving time - time to arrival - time to empty - alarm - miles or kilometers traveled since fill-up - miles or kilometers traveled on trip - miles or kilometers to arrival - miles or kilometers to empty - gallons or liters of fuel used since fill-up - gallons or liters of fuel used on trip - gallons or liters of fuel to

arrival - gallons or liters of fuel to empty - miles or kilometers per hour (current) - average miles or kilometers per hour for trip - current gallons or liters of fuel used per hour - average gallons or liters used on trip - current fuel efficiency in miles per gallon or kilometers per liter - average fuel efficiency for trip in miles per gallon or kilometers per liter - inside and outside (or coolant) temperature in degrees Fahrenheit or Celsius - battery voltage - cruise control - night time display dimming...

HUMAN ENGINEERING: The Compucruise has back-lit buttons that are easy to read at night and a florescent display that can be seen easily in the day-time and can be dimmed to eliminate night-time distractions. Each button is marked to indicate function, for example "Dist" for distance and "TE" for "to empty". A few minutes and you'll be familiar with your Compucruise. If you do make an error, the display will read "Error" and the alarm will buzz. Simple, isn't it!

TRY IT NOW

You could wait until automobile makers include all 44 computer functions as standard features on new cars. Or, if you want to start driving with full knowledge of car and fuel efficiency, time management and the convenience of cruise control, order your Compucruise now. Also if you're not 100% satisfied and agree that this is the most useful and practical automotive accessory since the foot brake, return the complete unit within 30 days for a full refund.

Complete computer with cruise control and all parts necessary for installation is only \$199.00. If your car is already equipped with cruise control, the computer alone (with installation accessories) is available for \$159.00. Add \$3.50 for shipping and handling. You can send a check or charge it to your Master Charge, VISA or American Express account. Don't delay the convenience and enjoyment of driving with knowledge. Give us a call at 414/377-5050 or send your order to:

ECHO®

ECHO COMMUNICATIONS, INC.

One Echo Plaza Cedarburg, WI 53012

OR CALL: 1 (414) 377-5050

©ECHO COMMUNICATIONS, INC. 1979

Phone toll free, 800-558-5151

See the logic of it all with B&K-PRECISION logic and pulser probes



DP-50 \$50

DP-100 \$80

Armed with only two portable instruments, you can now trace logic levels through the most popular types of logic circuitry... TTL, MOS, CMOS, even HTL and HiNIL.

The new B&K-PRECISION DP-100 is a digital pulser probe that's a great aid to fast analysis and debugging of integrated circuit logic systems. Simple to operate, the DP-100 can be used alone or with a logic probe or oscilloscope. It generates a "one shot" pulse train at a 5 Hz rate and senses circuit conditions to pull an existing high state to a low or a low state to a high.

The B&K-PRECISION DP-50 is the digital probe that offers more than logic. In addition to logic status, it actually displays pulse presence to 50 MHz. The intensity of its PULSE LED reveals the duty cycle of the signal observed.

Both the DP-50 and DP-100 are well protected against overload and accidental polarity reversal. You can see the logic of it all today! Contact your B&K-PRECISION distributor for immediate delivery.

B&K PRECISION
DYNASCAN
CORPORATION

6460 West Cortland Street
Chicago, Illinois 60635 • 312/889-9087

In Canada: Atlas Electronics, Ontario
Intl. Sls: Empire Exp., 270 Newtown Rd., Plainville, L.I., NY 11803

CIRCLE NO. 13 ON FREE INFORMATION CARD

11:00-11:15 a.m.	1600-1615	R. Japan	C	9505
11:00-11:15 a.m.	1600-1615	R. Pakistan	C	21755, 21595, 21485, 17665, 17640
11:00-11:30 a.m.	1600-1630	R. Korea	C	11830, 9720
11:00-11:30 a.m.	1600-1630	R. Norway	B	17755, 15175 (Sun only)
11:00-12:00 a.m.	1600-1700	VOA	A	26040, 21485, 17870, 17710, 15445, 15410
11:00 a.m.-12:45 p.m.	1600-1745	BBC	B	21710, 21550, 17880, 17830, 11775
11:00 a.m.-1:00 p.m.	1600-1800	AFRTS-Washington	A	17785, 15430, 15330, 11805
11:05-11:55 a.m.	1605-1655	R. France International	B	21705, 21595, 21580, 17860, 17850, 17720
				(1705-1755 from October)
11:10-11:55 a.m.	1610-1655	BRT, Belgium	C	21475, 17745 (frequent changes)
				(1710-1755 from October)
00:00-11:30 a.m.	-1630	R. Singapore	C	11940 (fade-in time varies)
11:45-12:00 a.m.	1645-1700	R. Canada International	A	21695, 17820, 15325
12:00-12:15 p.m.	1700-1715	R. Japan	C	9505
12:00-12:15 p.m.	1700-1715	Vatican R.	B	17900
12:00-12:30 p.m.	1700-1730	R. Pakistan	C	15470, 11675
12:00-1:00 p.m.	1700-1800	HCJB, Ecuador	B	21480, 17825 (frequent changes)
12:00-1:00 p.m.	1700-1800	VOA	A	26040, 21590, 21485, 17870, 17710, 15445, 15410, 15195
12:45-3:00 p.m.	1745-2000	BBC	C	15400, 15070, 12095
				(11820 from 1800)
12:45-5:30 p.m.	1745-2230	All India R.	C	11620
1:00-1:15 p.m.	1800-1815	R. Japan	B	9505
1:00-1:30 p.m.	1800-1830	R. Canada International	B	17820, 15260
1:00-1:30 p.m.	1800-1830	R. Norway	C	15175 (Sun only)
1:00-1:45 p.m.	1800-1845	R. Korea	C	15255, 11830
1:00-2:00 p.m.	1800-1900	V. of Revolution, Guinea	B	15308, (varies) (Mon, Wed, Fri; Sunday 1815-1900)
1:00-2:00 p.m.	1800-1900	V. of Nigeria	C	15119, 15185
1:00-3:00 p.m.	1800-2000	R. Australia	C	11800
1:00-4:00 p.m.	1800-2100	R. Kuwait	C	11690 (frequent changes)
1:00-5:00 p.m.	1800-2200	AFRTS-Washington	A	21570, 17765, 15430, 15330, 11790
1:00-5:00 p.m.	1800-2200	VOA	A	26040, 21590, 21485, 17870, 17785, 17710, 15445, 15410, 15250, 15140
1:15-1:45 p.m.	1815-1845	Swiss R. International	C	21585
1:15-2:15 p.m.	1815-1915	R. Bangladesh	D	15285, 11765 (both vary, freq. changes)
1:30-1:35 p.m.	1830-1835	UN Radio	A	21670, 19505-SSB, 15410 (Mon-Fri)
1:45-2:15 p.m.	1845-1915	Sri Lanka Br. Corp.	C	17850, 15120, 15115, 11870
1:45-3:00 p.m.	1845-2000	R. Ivory Coast	C	11920
2:00-2:10 p.m.	1900-1910	R. Tahiti	C	15170, 11825 (exc Sun)
2:00-2:15 p.m.	1900-1915	R. Japan	C	15270
2:00-2:30 p.m.	1900-1930	R. Canada International	A	21695, 17750, 15325
2:00-2:30 p.m.	1900-1930	R. Afghanistan	B	17820, 15260
2:00-3:00 p.m.	1900-2000	B.S.K. Saudi Arabia	C	15075 (frequent changes)
2:00-3:00 p.m.	1900-2000	HCJB, Ecuador	C	11855
2:45-4:10 p.m.	1945-2110	R. Free Grenada	C	21480, 17765, 15420 (freq. changes)
3:00-3:15 p.m.	2000-2015	R. Japan	C	15104 (time varies)
3:00-3:30 p.m.	2000-2030	V. of Iran	B	15270
3:00-3:30 p.m.	2000-2030	R. Algeria	C	9139 or 9022 (frequent changes)
3:00-3:30 p.m.	2000-2030	R. Canada International	C	11633, 9510
3:00-3:30 p.m.	2000-2030	Kol Israel	A	21695, 17820, 17750, 15325
3:00-4:15 p.m.	2000-2115	BBC	B	17645, 15415, 11655
3:10-4:40 p.m.	2010-2140	R. Habana Cuba	A	21710, 17840, 15260, 15070, 6175
3:30-4:20 p.m.	2030-2120	R. Nederland	A	17855
3:30-4:30 p.m.	2030-2130	V. of Vietnam	B	21640, 17695, 17605, 11740, 11730
3:50-4:40 p.m.	2050-2140	R. Habana Cuba	C	15012, 10040
4:00-4:15 p.m.	2100-2115	R. Japan	C	17750, 9770
4:00-4:50 p.m.	2100-2150	R. RSA	B	15270
4:00-5:00 p.m.	2100-2200	V. of Nigeria	B	21535, 17780, 15155
4:00-6:00 p.m.	2100-2300	CBC Radio	C	15185, 15119
4:15-5:00 p.m.	2115-2200	BBC	A	17820, 15325 (Mon-Fri)
4:15-7:00 p.m.	2115-2400	R. Free Grenada	A	21710, 15420, 15260, 15070, 11750, 6175
4:30-5:00 p.m.	2130-2200	R. Canada International	B	15045 (time varies)
4:30-5:00 p.m.	2130-2200	KGEI, San Francisco	A	17750, 15150, 11945 (Sat & Sun also 17820, 15325)
4:30-5:00 p.m.	2130-2200	HCJB Ecuador	C	15280
4:30-5:00 p.m.	2130-2200	R. Sofia	C	21480, 17765, 15295 (frequent changes)
4:30-5:30 p.m.	2130-2230	R. Baghdad	B	15135, 11750 (frequent changes)
4:30-6:00 p.m.	2130-2300	V. of Turkey	C	9745
4:40-5:40 p.m.	2140-2240	V. of Free China	C	11955, 11880, 9515, 7170
5:00-5:15 p.m.	2200-2215	R. Yugoslavia	C	17890, 15345, 11745
5:00-5:15 p.m.	2200-2215	R. Japan	C	9620
5:00-5:30 p.m.	2200-2230	R. Nacional, Venezuela	C	17755
5:00-5:30 p.m.	2200-2230	R. Norway	B	15400 (irregular)
5:00-5:45 p.m.	2200-2245	BBC	C	17795, 15345 (Sun only)
5:00-6:00 p.m.	2200-2300	VOA	A	21710, 15420, 15260, 15070, 6175, 6120
5:00-7:00 p.m.	2200-2400	CBC Southern Service	A	26040, 21485, 17870, 17710, 15445, 15410, 15250
5:00-7:00 p.m.	2200-2400	AFRTS-Washington	B	9755, 5960 (Mon-Fri) (2300-0100 from Oct. 29)
5:30-6:00 p.m.	2230-2300	Kol Israel	A	21570, 17765, 15430, 15330, 11790
5:45-6:00 p.m.	2245-2300	BBC	A	17815, 15300, 12085, 11655, 9815
5:45-6:00 p.m.	2245-2300	SDORE, Uruguay	A	15420, 15260, 15070, 9410
5:45-6:00 p.m.	2245-2300	UN Radio	C	6175, 6120
6:00-6:30 p.m.	2300-2330	R. Japan	C	11885, 9515 (time varies)
6:00-6:30 p.m.	2300-2330	R. Korea	A	15225, 11920 (Mon-Fri)
6:00-6:30 p.m.	2300-2330	R. Sweden	C	17755
6:00-6:30 p.m.	2300-2330	R. Vilnius	C	15570, 15385, 15345 (frequent changes)
			C	15275, 11705
			B	17870, 15525, 15405, 15180, 11790, 11735

6:00-6:50 p.m.
6:00-7:00 p.m.
6:00-7:00 p.m.
6:00-7:00 p.m.
6:00-7:00 p.m.

2300-2350 Rdif. Argentina
2300-2400 VOA
2300-2400 FEBC, Philippines
2300-2400 AVEH, Haiti
2300-2400 R. Moscow

C 11710 (Mon-Fri)
A 26095, 21610, 21460, 17895, 17820
C 15450
B 11835, 9770
A 21560, 17760, 17700, 15425, 12050,
12030, 11960, 11780, 11770, 11750,
9600

6:00-7:30 p.m.

2300-2430 BBC

A 15420, 15260, 15070, 11910, 9590,
9580, 9410, 7325, 6175, 6120
C 9977

6:00-7:50 p.m.
6:00-9:00 p.m.
6:00 p.m.-1:06 a.m.
6:05-6:20 p.m.
6:30-7:00 p.m.
6:45-7:45 p.m.
7:00-7:15 p.m.
7:00-7:25 p.m.
7:00-7:30 p.m.
7:00-7:30 p.m.
7:00-7:55 p.m.
7:00-8:00 p.m.

2300-2450 R. Pyongyang
2300-0200 RTVD, Dom. Rep.
2300-0506 CBC Northern Service
2305-2320 Austrian R.
2330-2400 R. Finland
2345-2445 R. Japan
0000-0015 R. Japan
0000-0025 R. Tirana
0000-0030 R. Norway
0000-0030 R. Canada International
0000-0055 R. Peking
0000-0100 VOA

B 9505 (not all Eng.)
B 9625, 6195 (not all English)
C 12015, 9770, 5945 (Sun only)
B 15270, 11755 (frequent changes)
B 17825, 15270
C 17755
B 9750, 7065
C 11860, 9605 (Mon only)
A 9755, 5960 (thru Oct. 28 only)
B 17680, 15520, 15115
A 21460, 17895, 17820, 15205,
11740, 9650, 6130
B 9705 or 15330
C 6090
A 21560, 17760, 17700, 15425, 12050,
11960, 11780, 11770, 11750, 9600,
9530

7:00-8:00 p.m.
7:00-9:00 p.m.
7:00-9:00 p.m.

0000-0100 R. Sofia
0000-0200 R. Luxembourg
0000-0200 R. Moscow

C 17810
B 11880, 9630
B 11730, 9655, 9515
B 15175, 11715
C 11885, 9515 (time varies)
C 15290
C 9630, 6055
B 17870, 15405, 15180, 15525,
11735, 9800

7:00-12:00 p.m.
7:05-8:55 p.m.
7:15-7:30 p.m.
7:15-8:00 p.m.
7:30-7:50 p.m.
7:30-8:00 p.m.
7:30-8:00 p.m.
7:30-8:00 p.m.

0000-0500 FEBC Philippines
0005-0155 Spanish Foreign R.
0015-0030 V. of Greece
0015-0100 BRT, Belgium
0030-0050 SODRE, Uruguay
0030-0100 R. Sweden
0030-0100 R. Prague
0030-0100 R. Kiev

D 4875 (Mon only)
A 15265
A 15260, 15070, 11910, 11750, 9580,
9410, 7325, 6175, 6120, 5975
B 11915, 9745
B 11925
C 17755

7:30-8:00 p.m.
7:30-9:00 p.m.
7:30-9:30 p.m.

0030-0100 Le Cruz del Sur, Bolivia
0030-0200 HCJB, Ecuador
0030-0230 BBC

B 11845, 9605, 6015
B 11800 and 15315 or 9575
A 17820, 9615, 5960
C 11970, 9730

7:30-12:00 p.m.
7:50-8:35 p.m.
8:00-8:15 p.m.
8:00-8:15 p.m.
8:00-8:20 p.m.
8:00-8:30 p.m.
8:00-8:45 p.m.
8:00-8:55 p.m.
8:00-8:55 p.m.
8:00-9:00 p.m.
8:00-9:00 p.m.
8:00-10:30 p.m.
8:00-11:30 p.m.
8:00-11:50 p.m.
8:00-12:00 p.m.
8:15-9:30 p.m.
8:30-8:50 p.m.

0030-0500 HCJB, Ecuador
0050-0135 TWR-Bonaire
0100-0115 R. Japan
0100-0115 Vatican R.
0100-0120 RAI, Italy
0100-0130 R. Canada International
0100-0145 R. Berlin International
0100-0155 R. Prague
0100-0155 R. Peking
0100-0200 VOA
0100-0200 V. of Free China
0100-0330 R. Australia
0100-0430 AFRTS-Washington
0100-0450 R. Habana Cuba
0100-0500 WYFR, Family Radio
0115-0230 R. Free Grenada
0130-0150 V. of Germany

B 11990, 9740, 9540, 7345, 5930
B 17680, 15520, 15115
A 15205, 11740, 9650, 6130
C 17890, 15345, 15270

8:30-8:55 p.m.
8:30-8:55 p.m.
8:30-9:00 p.m.

0130-0155 Austrian Radio
0130-0155 R. Tirana
0130-0200 R. Budapest

B 21740, 17795
A 21570, 17765, 15430, 9685, 6030
A 11930, 11725
A 9715

8:30-9:25 p.m.

0130-0225 R. Bucharest

B 15104 (irregular, time varies)
A 11865, 9605, 9565, 9545, 6145
6100, 6085, 6040
B 9770, 5945
B 9750, 7120

8:30-9:30 p.m.
8:45-9:15 p.m.
9:00-9:15 p.m.
9:00-9:25 p.m.

0130-0230 R. Japan
0145-0215 Swiss R. International
0200-0215 R. Japan
0200-0225 R. Warsaw

C 15380, 11940, 11840, 11735,
9690, 9570, 5990
C 21640, 17825, 17725, 15270
B 15305, 11715, 9725, 6135
C 17755

9:00-9:30 p.m.
9:00-9:30 p.m.
9:00-9:30 p.m.

0200-0230 R. Canada International
0200-0230 R. Norway
0200-0230 R. Budapest

C 15120, 11815, 9525, 7270,
7145, 6135, 6085
A 11940, 9615, 5960
B 11870, 11860, 9610 (Mon only)

9:00-9:50 p.m.
9:00-9:55 p.m.
9:00-10:00 p.m.

0200-0250 R. RSA
0200-0255 R. Peking
0200-0300 R. Moscow

B 17710, 15225, 11910, 9835, 9585,
6105 (Wed, Fri only)
C 15380, 11940, 11840, 11735,
9690, 9570, 5990

9:00-10:30 p.m.
9:15-9:30 p.m.
9:30-9:45 p.m.
9:30-9:55 p.m.
9:30-10:00 p.m.
9:30-10:00 p.m.
9:30-10:15 p.m.
9:30-10:25 p.m.
9:30-10:30 p.m.

0200-0330 R. Cairo
0215-0230 V. of Greece
0230-0245 R. Pakistan
0230-0255 R. Tirana
0230-0300 R. Lebanon
0230-0300 R. Sweden
0230-0315 R. Berlin International
0230-0325 R. Nederland
0230-0330 BBC

B 15220, 11900, 9610, 9585
B 17855, 17680, 15115
A 21960, 17760, 17700, 15225, 12050,
11960, 11780, 11770, 11750, 9700,
9685, 9600, 9530

9:50-11:00 p.m.
10:00-10:15 p.m.
10:00-10:15 p.m.
10:00-10:25 p.m.

0250-0400 TIFC, Costa Rica
0300-0315 R. Japan
0300-0315 Austrian Radio
0300-0325 R. Warsaw

B 12050, 9475
B 11730, 9655, 9515
C 21590, 17830
B 9750, 7120
C 15285 (frequent changes)
C 11705, 9695
C 11970, 9730

10:00-10:30 p.m.
10:00-10:30 p.m.

0300-0330 R. Canada International
0300-0330 R. Portugal

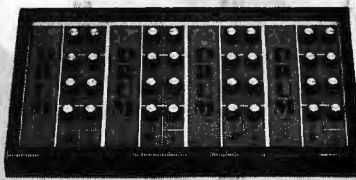
A 9590, 6165
A 15070, 11910, 11750, 9580, 9410,
7325, 6175, 6120, 5975
B 5055
C 17755

C 9770, 5945 (Sun only)
C 15120, 11815, 9525, 7270, 7145,
6135, 6095
A 11940, 11845, 9560, 9535, 5960
B 11835, 6025 (Mon-0320)

the DRUM T.M. by PAPA

PERCUSSION SYNTHESIZER

- * Modular design provides flexibility to realize as large or small a system as you need.
- * Continuously variable controls rather than switches allow true synthesizer versatility.
- * Numerous rear panel interfacing and control options permit multi-voice patches.
- * Variety of sensor mounting options, permanent or temporary, on your own drum set or our practice pads.
- * Available as quick and easy to assemble kit — \$269.75; or factory wired and tested — \$399.95.



- () I'm Sold, Send the 5700P The Drum package kit \$269.75 enclosed
- () Send the 5700P-A The Drum assembled \$399.95 enclosed
- () Send Assembly & Using Manual for The Drum, \$5.00 enclosed (refundable upon purchase)
- () SEND FREE CATALOG

Name: _____

Address: _____

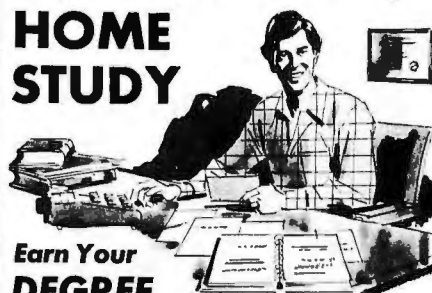
City: _____ State: _____ Zip: _____

PAPA ELECTRONICS, Dept. 10-P, 1020 N. W. Highway, Philadelphia City, OK 73116

CIRCLE NO. 45 ON FREE INFORMATION CARD

Put Professional Knowledge and a COLLEGE DEGREE in your Electronics Career through

HOME STUDY



Earn Your DEGREE

by correspondence, while continuing your present job. No commuting to class. Study at your own pace. Learn from complete and explicit lesson materials, with additional assistance from our home-study instructors. Advance as fast as you wish, but take all the time you need to master each topic.

The Grantham electronics degree program begins with basics, leads first to the A.S.E.T. degree, and then to the B.S.E.T. degree. Our *free* bulletin gives complete details of the program itself, the degrees awarded, the requirements for each degree, and how to enroll. (We are located at 2500 S. LaCienega Bl., Los Angeles, Calif.) Write to our mailing address shown below for *Bulletin E-79*.

Grantham College of Engineering
P. O. Box 35499
Los Angeles, California 90035

Worldwide Career Training thru Home Study

PROJECTS FOR EXPERIMENTERS AND HOBBYISTS... INCLUDING A PERSONAL COMPUTER BUYING GUIDE AND PRODUCT DIRECTORY



Published each year by the editors of Popular Electronics, here's the one publication that helps you get it together with a score of money-saving and unique build-it-yourself projects. It will again be packed with electronic projects information, complete with full construction plans that are sure to provide successful days and months of building fun and years of practical use. The issue also includes a personal computer buying guide and product directory.

The all-new 1980 edition goes on sale nationally November, 1979.

RESERVE YOUR COPY NOW AT THE PRE-PUBLICATION PRICE OF \$1.95 ONLY...

This offer is being made to readers of Popular Electronics only. Newsstand price is \$2.50; mail order \$3. Save money and enjoy the convenience of having the 1980 ELECTRONIC EXPERIMENTER'S HANDBOOK mailed to you from first-off-the-press copies when published. Complete the Reservation Form and return it promptly with your remittance.

Pre-Publication Reservation Form

Electronic Experimenter's Handbook,
Dept. 01237, P.O. Box 278,
Pratt Station, Brooklyn, NY 11205

Enclosed is \$1.95* (outside USA \$2.50)
for the 1980 ELECTRONIC EXPERI-
MENTER'S HANDBOOK to be mailed to
me in November, 1979 when published.

Print Name _____

Address _____

City _____

State _____ Zip _____

*Residents of CA, CO, DC, FL, IL, MI,
MO, NY STATE, and VT add applicable
sales tax.

10:00-10:30 p.m.	0300-0330	R. Budapest	B	17710, 15225, 11910, 9835, 9585, 6105
10:00-10:30 p.m.	0300-0330	R. Kiev	B	17870, 15405, 15180, 11920, 11735, 9800, 9655
10:00-10:30 p.m.	0300-0330	R. Australia	C	15260 (Fri. only)
10:00-10:50 p.m.	0300-0350	V. of Free China	C	17890, 15345
10:00-10:55 p.m.	0300-0355	R. Prague	B	11990, 9740, 9540, 7345, 5930
10:00-10:55 p.m.	0300-0355	R. Peking	B	17680, 15300, 12055, 11685
10:00-11:00 p.m.	0300-0400	RAE, Argentina	C	9690 (Tue-Sat)
10:00-11:00 p.m.	0300-0400	Radiobras, Brazil	A	15290
10:00-11:00 p.m.	0300-0400	R. Baghdad	C	11935
10:00-11:00 p.m.	0300-0400	R. Moscow	B	17760, 17700, 12050, 11960, 11770, 11750, 11720, 9710 (from 0330), 9700, 9685, 9600, 9530
10:00-11:15 p.m.	0300-0415	R. Uganda	B	15325
10:00-11:26 p.m.	0300-0426	R. RSA	B	15220, 11900, 9585, 7270, 5980
10:00-11:30 p.m.	0300-0430	R. Cultural, Guatemala	B	3300
10:00 p.m.-2:30 a.m.	0300-0730	VOA	A	17865, 15245, 9670, 5995
10:30-10:55 p.m.	0330-0355	R. Tirana	B	7300, 6200
10:30-10:55 p.m.	0330-0355	Austrian Radio	C	9770, 5945
10:30-11:00 p.m.	0330-0400	R. Australia	B	17795
10:30-11:15 p.m.	0330-0415	R. Berlin International	B	11970, 11890, 11840
10:30-11:45 p.m.	0330-0445	BBC	A	11910 (to 0430), 9410, 6175, 5975
10:30-12:00 p.m.	0330-0500	R. Tanzania	D	15435
10:30 p.m.-1:00 a.m.	0330-0600	R. Habana Cuba	A	11760
10:51-10:58 p.m.	0351-0358	V. of Yerevan	C	17870, 15535, 15405, 15180 (Sun, Wed, Thu, Sat)
11:00-11:15 p.m.	0400-0415	R. Japan	C	17755
11:00-11:15 p.m.	0400-0415	R. Budapest	B	17710, 15225, 11910, 9835, 9585, 6105 (Wed & Sat) (Mon-0430)
11:00-11:30 p.m.	0400-0430	R. Bucharest	C	15380, 11940, 11840, 11735, 9690, 9570, 5990
11:00-11:30 p.m.	0400-0430	R. Canada International	A	11845, 9560, 9535, 5960
11:00-11:30 p.m.	0400-0430	R. Norway	B	11860, 9645 (Mon only)
11:00-11:45 p.m.	0400-0445	R. Korea	C	15570, 11820
11:00-11:55 p.m.	0400-0455	R. Peking	B	17680, 15300, 12055, 11685
11:00-12:00 p.m.	0400-0500	R. Moscow	B	17780, 15180, 12030, 12000, 11720, 9730, 9710
11:00-12:00 p.m.	0400-0500	R. Australia	B	17795, 15320
11:30-11:55 p.m.	0430-0455	Austrian R.	B	15260
11:30-12:00 p.m.	0430-0500	Swiss R. International	B	15305 (SSB), 11715, 9725
11:30-12:00 p.m.	0430-0500	R. Sofia	B	11750 (frequent changes)
11:30 p.m.-2:00 a.m.	0430-0700	AFRTS-Washington	A	17765, 15430, 9755, 6030
11:45 p.m.-12:45 a.m.	0445-0545	BBC	A	9510, 6175, 5975
11:55 p.m.-1:30 a.m.	0455-0630	V. of Nigeria	C	15185, 15120, 7255
12:00-12:15 a.m.	0500-0515	Kol Israel	B	17815, 15495, 15105, 11655
12:00-12:15 a.m.	0500-0515	R. Japan	C	15270
12:00-12:30 a.m.	0500-0530	R. Portugal	B	11935, 6025 (Mon-0520)
12:00-1:00 a.m.	0500-0600	R. Australia	C	21680, 17725, 17870, 17725, 15240
12:00-2:00 a.m.	0500-0700	HCB, Ecuador	B	11915, 9745, 6095
12:00-3:00 a.m.	0500-0800	R. Moscow	B	12050, 12030, 12000, 11750 (from 0600), 11720, 9730, 9710
12:15-1:15 a.m.	0515-0615	Spanish Foreign R.	B	11880, 9630
12:22-12:30 a.m.	0522-0530	UN Radio	A	9540, 6055 (Tue-Sat)
12:30-12:50 a.m.	0530-0550	V. of Germany	A	11905, 11785, 9650, 9545, 6185, 5960
12:30-1:25 a.m.	0530-0625	R. Nederland	A	9715, 6165
12:45-1:00 a.m.	0545-0600	UN Radio	A	9540, 6135 (Tue-Sat)
12:45-2:30 a.m.	0545-0730	BBC	B	15070, 11955, 11860, 9640, 9510, 6175
1:00-1:15 a.m.	0600-0615	R. Japan	C	15270
1:00-1:30 a.m.	0600-0630	R. Norway	B	11860 (Mon only)
1:00-1:30 a.m.	0600-0630	R. Australia	C	21680, 21525, 17725, 17555, 15240
1:00-2:00 a.m.	0600-0700	RAE, Argentina	C	9690 (Tue-Sat only)
1:00-2:00 a.m.	0600-0700	R. RSA	C	21535, 17760
1:15-1:30 a.m.	0615-0630	R. Canada International	B	11960, 11825, 9855, 9590, 6140 (Mon-Fri)
1:25-3:55 a.m.	0625-0855	V. of Malaysia	C	15295, 12350, 9750
1:30-2:00 a.m.	0630-0700	R. Australia	B	21680, 17725, 15240, 9670
1:30-3:00 a.m.	0630-0800	R. Habana Cuba	A	9525
1:40-7:15 a.m.	0640-1215	R. New Zealand	C	6105
1:45-2:00 a.m.	0645-0700	R. Canada International	B	11960, 11825, 9655, 9590, 6140 (Mon-Fri)
2:00-2:15 a.m.	0700-0715	R. Japan	C	15270
2:00-3:00 a.m.	0700-0800	Xandir Malta	D	9670 (Sat only) (frequent changes)
2:00-4:00 a.m.	0700-0900	R. Australia	B	21680, 17725, 11740, 9670, 9570
2:07-2:15 a.m.	0707-0715	UN Radio	A	9540, 6135 (Tue-Sat)
2:30-2:45 a.m.	0730-0745	UN Radio	A	9540, 6135 (Tue-Sat)
2:30-3:25 a.m.	0730-0825	R. Nederland	B	9770, 9715
2:30-4:00 a.m.	0730-0900	BBC	B	15070, 11955, 9640, 9510
2:55 a.m.-fade	0755-	Action Radio, Guyana	C	5950
3:00-3:15 a.m.	0800-0815	R. Japan	B	9505
3:00-5:00 a.m.	0800-1000	FEBC, Philippines	C	11765
3:30-4:25 a.m.	0830-0925	R. Nederland	B	9715

Explanatory Notes.

1. Times in first column are CDT. For EDT, add 1 hour. MDT, subtract 1 hour. PDT, subtract 2 hours. Days of week are in GMT.
2. Quality. A—strong signal and very reliable reception. B—regular reception. C—occasional reception under favorable conditions. D—rarely audible. These ratings are for locations in the central USA. European and African stations are in general, more reliably received in eastern North America. Asian and Pacific stations are more reliably received in western North America. North American stations are received well except in areas too close to the transmitter site.
3. The information in this listing is correct to press time. However, frequencies and schedules are constantly changing. Listen to "DX Digest" on R. Canada International for late changes, Sunday at 1807; 1915 (to Europe); GMT Mondays at 0017, 0117 and 0317; and Wednesdays at 2145.
4. R.—Radio; V.—Voice

PROJECT OF THE MONTH

BY FORREST M. MIMS

UNIVERSAL TRI-STATE TONE GENERATOR

AMONG the most popular applications of tone generators are those of annunciators and alarms. The tri-state tone generator shown in Fig. 1 is more versatile in this use than most because it has three principle operating modes: steady, pulsating, and two-tone. It can be easily modified to produce a warbling sound and can generate a wide range of audible frequencies.

Each half of a 556 dual timer functions as an astable multivibrator. The first astable, whose timing components are $R1$, $R2$, and $C1$, oscillates at a frequency of slightly more than two hertz. The second astable, which drives a small 8-ohm dynamic speaker, is programmed by $R4$, $R5$, and $C4$ to oscillate at a frequency of 2.5 kHz. Resistor $R6$ governs the volume of the sound from the speaker.

The three principle operating modes are selected by $S1$, an spdt toggle switch with a neutral (off) center position. Position 1 connects the output of the first astable to the second astable through $R3$. The result is an attention-getting, two-tone signal whose frequency fluctuates between 2200 and 2500 Hz at a rate determined by the rate of oscillation of the first astable.

Position 2 disconnects the first astable from the second astable, allowing the second to operate independently. Consequently, the speaker emits a steady 2500-Hz tone. Position 3 connects the output of the first astable directly to the reset input of the second astable. This causes the 2500-Hz tone applied to the speaker to be interrupted at a rate determined by the first astable. The result is a series of tone bursts.

You can experiment with the timing components of both astable multivibrators to achieve a wider range of tone modes and frequencies than those described above. Increasing the capacitance of $C1$ to 10 microfarads or more, for example, will reduce the frequency of oscillation of the first astable to approximately 0.7 hertz. On the other hand, reducing $C1$ to 0.45 microfarads will increase the first astable's oscillation frequency to about 15 Hz, causing a distinct warble to be heard when $S1$ is in position 1 or a rapid series of tone bursts when $S1$ is in position 3.

The frequency of the second astable can be made adjustable by replacing $R4$ and $R5$ with a 15,000-ohm potentiometer. To do so, connect the wiper of the potentiometer to pin 13 of the 556 and the stationary terminals to pins 8 and 14. You can make

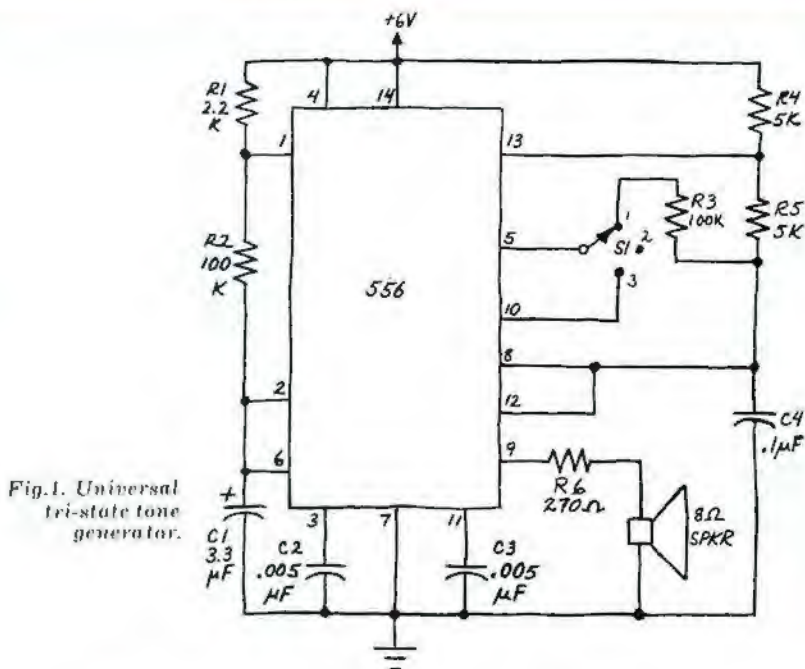


Fig. 1. Universal tri-state tone generator.

one or both astable responsive to changes in the level of ambient light by substituting a cadmium-sulfide photocell for one or more of the timing resistors.

Digital Tone Mode Selection. It's possible to select the tone mode electronically with the help of a 4051 CMOS analog multiplexer/demultiplexer. Figure 2 shows how the 4051 is introduced into the circuit in place of $S1$.

A two-bit word selects the desired tone mode according to the truth table included in Fig. 2. Note the addition of a fourth tone mode, a ticking sound similar to that of a metronome. This sound represents the output of the first astable and its frequency can be altered by changing $R1$, $R2$, $C1$, or

any combination of these components. When the metronome mode is selected, the second astable is disabled by the 4051.

You can modify the truth table in Fig. 2 by connecting any three of the eight analog switches in the 4051 to the rest of the circuit. Refer to the 4051 data sheet for details of the operation of this versatile chip.

Going Further. With a little ingenuity, you can select the desired tone mode—or turn the circuit on or off—with components other than the 4051. Try optoisolators, SCRs, transistors, or relays. You might even be able to add a tri-state LED to the circuit to provide simultaneous audible and visual outputs.

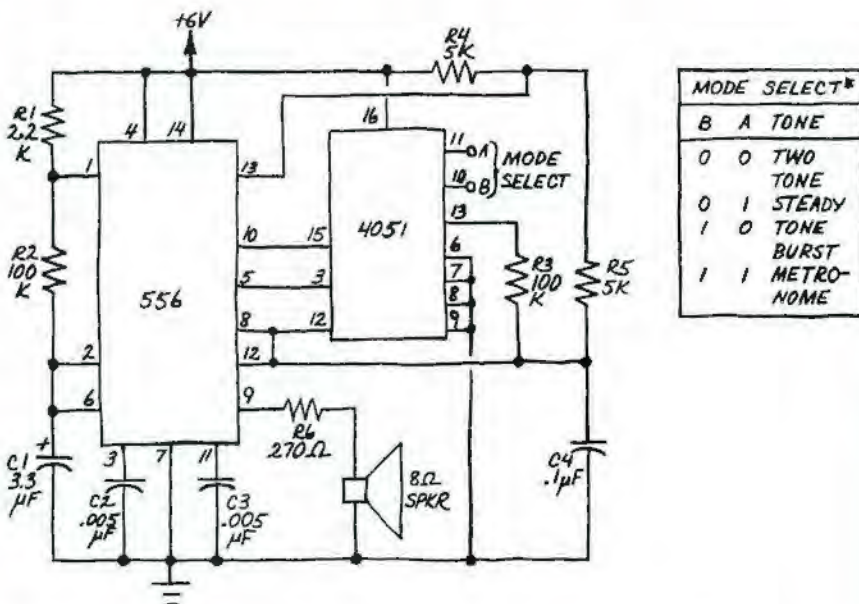


Fig. 2. Programmable four-state tone generator

MODE SELECT*		
B	A	TONE
0	0	TWO TONE
0	1	STEADY
1	0	TONE BURST
1	1	METRONOME

DIGI-KEY CORPORATION

Quality Electronic Components

TOLL FREE

MINN., AK., HI. RESIDENTS 218-681-6674

DON'T FORGET OUR DISCOUNTS WHEN COMPARING PRICES

I.C. Socket Prices Slashed

I.C. SOCKETS

* BOTH SOLIDTAN AND WIRE WRAP ARE IN STOCK
* SOLIDTAN SOCKETS ARE LOW PRICED
* WIRE WRAP SOCKETS ARE STANDARD PROFILE (LEVEL 3)

Part No.	Description	QTY	Price
8-57	8 Pin Solder Tab	100	8.00
14-57	14 Pin Solder Tab	100	14.00
16-57	16 Pin Solder Tab	100	16.00
18-57	18 Pin Solder Tab	100	18.00
20-57	20 Pin Solder Tab	100	20.00
22-57	22 Pin Solder Tab	100	22.00
24-57	24 Pin Solder Tab	100	24.00
26-57	26 Pin Solder Tab	100	26.00
28-57	28 Pin Solder Tab	100	28.00
30-57	30 Pin Solder Tab	100	30.00
32-57	32 Pin Solder Tab	100	32.00
34-57	34 Pin Solder Tab	100	34.00
36-57	36 Pin Solder Tab	100	36.00
38-57	38 Pin Solder Tab	100	38.00
40-57	40 Pin Solder Tab	100	40.00
42-57	42 Pin Solder Tab	100	42.00
44-57	44 Pin Solder Tab	100	44.00
46-57	46 Pin Solder Tab	100	46.00
48-57	48 Pin Solder Tab	100	48.00
50-57	50 Pin Solder Tab	100	50.00
52-57	52 Pin Solder Tab	100	52.00
54-57	54 Pin Solder Tab	100	54.00
56-57	56 Pin Solder Tab	100	56.00
58-57	58 Pin Solder Tab	100	58.00
60-57	60 Pin Solder Tab	100	60.00
62-57	62 Pin Solder Tab	100	62.00
64-57	64 Pin Solder Tab	100	64.00
66-57	66 Pin Solder Tab	100	66.00
68-57	68 Pin Solder Tab	100	68.00
70-57	70 Pin Solder Tab	100	70.00
72-57	72 Pin Solder Tab	100	72.00
74-57	74 Pin Solder Tab	100	74.00
76-57	76 Pin Solder Tab	100	76.00
78-57	78 Pin Solder Tab	100	78.00
80-57	80 Pin Solder Tab	100	80.00
82-57	82 Pin Solder Tab	100	82.00
84-57	84 Pin Solder Tab	100	84.00
86-57	86 Pin Solder Tab	100	86.00
88-57	88 Pin Solder Tab	100	88.00
90-57	90 Pin Solder Tab	100	90.00
92-57	92 Pin Solder Tab	100	92.00
94-57	94 Pin Solder Tab	100	94.00
96-57	96 Pin Solder Tab	100	96.00
98-57	98 Pin Solder Tab	100	98.00
100-57	100 Pin Solder Tab	100	100.00

TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

RELIABLE, COST-EFFECTIVE CONTACT DESIGN

* 20 (Wire Wrap) to 75 (Solder Tab) micro-line gold wire over a nickel diffusion barrier.
* Copper-clad base CA 215 alloy.
* Interlocked contact points.
* Precision, centerline spacing design.
* Contacts are user reversible.
* Dimensions are the same as the standard 240 pin connector.

Part No.	Description	QTY	Price
24-57	24 Pin Solder Tab	100	24.00
26-57	26 Pin Solder Tab	100	26.00
28-57	28 Pin Solder Tab	100	28.00
30-57	30 Pin Solder Tab	100	30.00
32-57	32 Pin Solder Tab	100	32.00
34-57	34 Pin Solder Tab	100	34.00
36-57	36 Pin Solder Tab	100	36.00
38-57	38 Pin Solder Tab	100	38.00
40-57	40 Pin Solder Tab	100	40.00
42-57	42 Pin Solder Tab	100	42.00
44-57	44 Pin Solder Tab	100	44.00
46-57	46 Pin Solder Tab	100	46.00
48-57	48 Pin Solder Tab	100	48.00
50-57	50 Pin Solder Tab	100	50.00
52-57	52 Pin Solder Tab	100	52.00
54-57	54 Pin Solder Tab	100	54.00
56-57	56 Pin Solder Tab	100	56.00
58-57	58 Pin Solder Tab	100	58.00
60-57	60 Pin Solder Tab	100	60.00
62-57	62 Pin Solder Tab	100	62.00
64-57	64 Pin Solder Tab	100	64.00
66-57	66 Pin Solder Tab	100	66.00
68-57	68 Pin Solder Tab	100	68.00
70-57	70 Pin Solder Tab	100	70.00
72-57	72 Pin Solder Tab	100	72.00
74-57	74 Pin Solder Tab	100	74.00
76-57	76 Pin Solder Tab	100	76.00
78-57	78 Pin Solder Tab	100	78.00
80-57	80 Pin Solder Tab	100	80.00
82-57	82 Pin Solder Tab	100	82.00
84-57	84 Pin Solder Tab	100	84.00
86-57	86 Pin Solder Tab	100	86.00
88-57	88 Pin Solder Tab	100	88.00
90-57	90 Pin Solder Tab	100	90.00
92-57	92 Pin Solder Tab	100	92.00
94-57	94 Pin Solder Tab	100	94.00
96-57	96 Pin Solder Tab	100	96.00
98-57	98 Pin Solder Tab	100	98.00
100-57	100 Pin Solder Tab	100	100.00

TIME-TEMPERATURE PROGRAMMABLE MODULE

USER PROGRAMMABLE FOR:

* 12 to 24 Hour Stability
* 100 to 1000 Hour Life Expectancy
* 100 to 1000 Hour Life Expectancy
* 100 to 1000 Hour Life Expectancy
* 100 to 1000 Hour Life Expectancy

Part No.	Description	QTY	Price
24-57	24 Pin Solder Tab	100	24.00
26-57	26 Pin Solder Tab	100	26.00
28-57	28 Pin Solder Tab	100	28.00
30-57	30 Pin Solder Tab	100	30.00
32-57	32 Pin Solder Tab	100	32.00
34-57	34 Pin Solder Tab	100	34.00
36-57	36 Pin Solder Tab	100	36.00
38-57	38 Pin Solder Tab	100	38.00
40-57	40 Pin Solder Tab	100	40.00
42-57	42 Pin Solder Tab	100	42.00
44-57	44 Pin Solder Tab	100	44.00
46-57	46 Pin Solder Tab	100	46.00
48-57	48 Pin Solder Tab	100	48.00
50-57	50 Pin Solder Tab	100	50.00
52-57	52 Pin Solder Tab	100	52.00
54-57	54 Pin Solder Tab	100	54.00
56-57	56 Pin Solder Tab	100	56.00
58-57	58 Pin Solder Tab	100	58.00
60-57	60 Pin Solder Tab	100	60.00
62-57	62 Pin Solder Tab	100	62.00
64-57	64 Pin Solder Tab	100	64.00
66-57	66 Pin Solder Tab	100	66.00
68-57	68 Pin Solder Tab	100	68.00
70-57	70 Pin Solder Tab	100	70.00
72-57	72 Pin Solder Tab	100	72.00
74-57	74 Pin Solder Tab	100	74.00
76-57	76 Pin Solder Tab	100	76.00
78-57	78 Pin Solder Tab	100	78.00
80-57	80 Pin Solder Tab	100	80.00
82-57	82 Pin Solder Tab	100	82.00
84-57	84 Pin Solder Tab	100	84.00
86-57	86 Pin Solder Tab	100	86.00
88-57	88 Pin Solder Tab	100	88.00
90-57	90 Pin Solder Tab	100	90.00
92-57	92 Pin Solder Tab	100	92.00
94-57	94 Pin Solder Tab	100	94.00
96-57	96 Pin Solder Tab	100	96.00
98-57	98 Pin Solder Tab	100	98.00
100-57	100 Pin Solder Tab	100	100.00

THE MA1023 BY NATIONAL SEMICONDUCTOR

THE "PROGRAMMABLE" CLOCK MODULE

* 0.7" HIGH DIGITS - RED LED DISPLAY
* 100 to 1000 Hour Life Expectancy
* 100 to 1000 Hour Life Expectancy
* 100 to 1000 Hour Life Expectancy
* 100 to 1000 Hour Life Expectancy

Part No.	Description	QTY	Price
24-57	24 Pin Solder Tab	100	24.00
26-57	26 Pin Solder Tab	100	26.00
28-57	28 Pin Solder Tab	100	28.00
30-57	30 Pin Solder Tab	100	30.00
32-57	32 Pin Solder Tab	100	32.00
34-57	34 Pin Solder Tab	100	34.00
36-57	36 Pin Solder Tab	100	36.00
38-57	38 Pin Solder Tab	100	38.00
40-57	40 Pin Solder Tab	100	40.00
42-57	42 Pin Solder Tab	100	42.00
44-57	44 Pin Solder Tab	100	44.00
46-57	46 Pin Solder Tab	100	46.00
48-57	48 Pin Solder Tab	100	48.00
50-57	50 Pin Solder Tab	100	50.00
52-57	52 Pin Solder Tab	100	52.00
54-57	54 Pin Solder Tab	100	54.00
56-57	56 Pin Solder Tab	100	56.00
58-57	58 Pin Solder Tab	100	58.00
60-57	60 Pin Solder Tab	100	60.00
62-57	62 Pin Solder Tab	100	62.00
64-57	64 Pin Solder Tab	100	64.00
66-57	66 Pin Solder Tab	100	66.00
68-57	68 Pin Solder Tab	100	68.00
70-57	70 Pin Solder Tab	100	70.00
72-57	72 Pin Solder Tab	100	72.00
74-57	74 Pin Solder Tab	100	74.00
76-57	76 Pin Solder Tab	100	76.00
78-57	78 Pin Solder Tab	100	78.00
80-57	80 Pin Solder Tab	100	80.00
82-57	82 Pin Solder Tab	100	82.00
84-57	84 Pin Solder Tab	100	84.00
86-57	86 Pin Solder Tab	100	86.00
88-57	88 Pin Solder Tab	100	88.00
90-57	90 Pin Solder Tab	100	90.00
92-57	92 Pin Solder Tab	100	92.00
94-57	94 Pin Solder Tab	100	94.00
96-57	96 Pin Solder Tab	100	96.00
98-57	98 Pin Solder Tab	100	98.00
100-57	100 Pin Solder Tab	100	100.00

PANASONIC ELECTROLYTIC CAPACITORS

ADJ. LEAD

Part No.	Description	QTY	Price
24-57	24 Pin Solder Tab	100	24.00
26-57	26 Pin Solder Tab	100	26.00
28-57	28 Pin Solder Tab	100	28.00
30-57	30 Pin Solder Tab	100	30.00
32-57	32 Pin Solder Tab	100	32.00
34-57	34 Pin Solder Tab	100	34.00
36-57	36 Pin Solder Tab	100	36.00
38-57	38 Pin Solder Tab	100	38.00
40-57	40 Pin Solder Tab	100	40.00
42-57	42 Pin Solder Tab	100	42.00
44-57	44 Pin Solder Tab	100	44.00
46-57	46 Pin Solder Tab	100	46.00
48-57	48 Pin Solder Tab	100	48.00
50-57	50 Pin Solder Tab	100	50.00
52-57	52 Pin Solder Tab	100	52.00
54-57	54 Pin Solder Tab	100	54.00
56-57	56 Pin Solder Tab	100	56.00
58-57	58 Pin Solder Tab	100	58.00
60-57	60 Pin Solder Tab	100	60.00
62-57	62 Pin Solder Tab	100	62.00
64-57	64 Pin Solder Tab	100	64.00
66-57	66 Pin Solder Tab	100	66.00
68-57	68 Pin Solder Tab	100	68.00
70-57	70 Pin Solder Tab	100	70.00
72-57	72 Pin Solder Tab	100	72.00
74-57	74 Pin Solder Tab	100	74.00
76-57	76 Pin Solder Tab	100	76.00
78-57	78 Pin Solder Tab	100	78.00
80-57	80 Pin Solder Tab	100	80.00
82-57	82 Pin Solder Tab	100	82.00
84-57	84 Pin Solder Tab	100	84.00
86-57	86 Pin Solder Tab	100	86.00
88-57	88 Pin Solder Tab	100	88.00
90-57	90 Pin Solder Tab	100	90.00
92-57	92 Pin Solder Tab	100	92.00
94-57	94 Pin Solder Tab	100	94.00
96-57	96 Pin Solder Tab	100	96.00
98-57	98 Pin Solder Tab	100	98.00
100-57	100 Pin Solder Tab	100	100.00

MOLLEX I.C. SOCKET PINS

INTEGRATED CIRCUITS

Part No.	Description	QTY	Price
24-57	24 Pin Solder Tab	100	24.00
26-57	26 Pin Solder Tab	100	26.00
28-57	28 Pin Solder Tab	100	28.00
30-57	30 Pin Solder Tab	100	30.00
32-57	32 Pin Solder Tab	100	32.00
34-57	34 Pin Solder Tab	100	34.00
36-57	36 Pin Solder Tab	100	36.00
38-57	38 Pin Solder Tab	100	38.00
40-57	40 Pin Solder Tab	100	40.00
42-57	42 Pin Solder Tab	100	42.00
44-57	44 Pin Solder Tab	100	44.00
46-57	46 Pin Solder Tab	100	46.00
48-57	48 Pin Solder Tab	100	48.00
50-57	50 Pin Solder Tab	100	50.00
52-57	52 Pin Solder Tab	100	52.00
54-57	54 Pin Solder Tab	100	54.00
56-57	56 Pin Solder Tab	100	56.00
58-57	58 Pin Solder Tab	100	58.00
60-57	60 Pin Solder Tab	100	60.00
62-57	62 Pin Solder Tab	100	62.00
64-57	64 Pin Solder Tab	100	64.00
66-57	66 Pin Solder Tab	100	66.00
68-57	68 Pin Solder Tab	100	68.00
70-57	70 Pin Solder Tab	100	70.00
72-57	72 Pin Solder Tab	100	72.00
74-57	74 Pin Solder Tab	100	74.00
76-57	76 Pin Solder Tab	100	76.00
78-57	78 Pin Solder Tab	100	78.00
80-57	80 Pin Solder Tab	100	80.00
82-57	82 Pin Solder Tab	100	82.00
84-57	84 Pin Solder Tab	100	84.00
86-57	86 Pin Solder Tab	100	86.00
88-57	88 Pin Solder Tab	100	88.00
90-57	90 Pin Solder Tab	100	90.00
92-57	92 Pin Solder Tab	100	92.00
94-57	94 Pin Solder Tab	100	94.00
96-57	96 Pin Solder Tab	100	96.00
98-57	98 Pin Solder Tab	100	98.00
100-57	100 Pin Solder Tab	100	100.00

MA1023, 100" x 200" EDGEBOARD CONNECTORS

RELIABLE, COST-EFFECTIVE CONTACT DESIGN

10-10	1.28	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
-------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

FREE INFORMATION:

Learning more about a product that's advertised or mentioned in an article in this month's issue is as simple as one, two, three. And absolutely free.

1 Print or type your name and address on the attached card. Use only one card per person.

2 Circle the number(s) on the card that correspond to the number(s) at the bottom of the advertisement or article for which you want more information. (Key numbers for advertised products also appear in the Advertisers' Index.)

3 Simply mail the card, and the literature will be mailed to you free of charge from the manufacturer.

FREE INFORMATION:

This address is for our product Free Information Service only. Editorial inquiries should be directed to POPULAR ELECTRONICS, One Park Avenue, New York, N.Y. 10016.

POPULAR ELECTRONICS

PE10793

USE ONLY ONE CARD PER PERSON

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

(Zip Code must be included to insure delivery.) (Void after Dec. 31, 1979)

Do you own a Function Generator? a. ☐ Yes b. ☐ No

Are you interested in hearing more about Function Generator?

a. ☐ Yes b. ☐ No

Do you plan on buying a Function Generator during the next 12 months? a. ☐ Yes b. ☐ No

4 ☐ Please send me 12 issues of Popular Electronics for \$8.97 and bill me.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120

POPULAR ELECTRONICS

PE10792

USE ONLY ONE CARD PER PERSON

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

(Zip Code must be included to insure delivery.) (Void after Dec. 31, 1979)

Do you own a Function Generator? a. ☐ Yes b. ☐ No

Are you interested in hearing more about Function Generator?

a. ☐ Yes b. ☐ No

Do you plan on buying a Function Generator during the next 12 months? a. ☐ Yes b. ☐ No

4 ☐ Please send me 12 issues of Popular Electronics for \$8.97 and bill me.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120

POPULAR ELECTRONICS

PE10791

USE ONLY ONE CARD PER PERSON

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

(Zip Code must be included to insure delivery.) (Void after Dec. 31, 1979)

Do you own a Function Generator? a. ☐ Yes b. ☐ No

Are you interested in hearing more about Function Generator?

a. ☐ Yes b. ☐ No

Do you plan on buying a Function Generator during the next 12 months? a. ☐ Yes b. ☐ No

4 ☐ Please send me 12 issues of Popular Electronics for \$8.97 and bill me.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120



No postage
necessary
if mailed
in the
United States

BUSINESS REPLY CARD

First Class Permit No. 217 Clinton, Iowa

POSTAGE WILL BE PAID BY

Popular Electronics

P.O. Box 2905
Clinton, Iowa 52732



No postage
necessary
if mailed
in the
United States

BUSINESS REPLY CARD

First Class Permit No. 217 Clinton, Iowa

POSTAGE WILL BE PAID BY

Popular Electronics

P.O. Box 2905
Clinton, Iowa 52732



No postage
necessary
if mailed
in the
United States

BUSINESS REPLY CARD

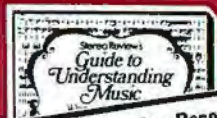
First Class Permit No. 217 Clinton, Iowa

POSTAGE WILL BE PAID BY

Popular Electronics

P.O. Box 2905
Clinton, Iowa 52732

An important set of
recordings created to
help you expand your
understanding
of music



FREE Stereo Demonstration Record
SEE DETAILS BELOW!

This unique four-disc album is interesting, easy to comprehend, and instructive. It is the first project of its kind to approach the understanding of music through its basic elements: rhythm . . . melody . . . harmony . . . texture.

Written and narrated exclusively for Stereo Review by David Randolph, Music Director of the Masterwork Music and Art Foundation, this fascinating set of stereo records will help you become a more sophisticated, more knowledgeable listener.

In the GUIDE TO UNDERSTANDING MUSIC, David Randolph first discusses, by means of recorded narration, how the composer uses and unifies all the basic musical elements. After each musical point is made in the narration, a musical demonstration of the point under discussion is provided. Thus you become a part of the creative musical process by listening, by understanding, by seeing how music's "raw materials" are employed by composers and performers to attain their highest level of expressivity and communication through musical form.

FOUR STEREO RECORDS

Record I—The Elements of Music: 1. Rhythm. 2. Melody 3. Harmony 4. Texture.

Record II—Sense and Sensation in Music: (The Instruments of the Orchestra)—How Music is Unified.

Record III—Form in Music—Words and Music.

Record IV—Can Music Tell a Story or Paint a Picture?—The Interpretation of Music.

OVER 200 MUSICAL EXAMPLES which have been carefully chosen from among thousands of recordings by major record companies as the best illustrations of musical points made in the recorded narration. In addition, supplementary musical demonstrations were specially recorded for this album.

BOOKLET ENCLOSED. The accompanying booklet is a valuable complement to the album. It presents David Randolph's straightforward professional approach to music, and shares the insights and understanding of his many years of experience in bringing music to listeners . . . as well as advice on how you can make the best use of the album.

If you already have some knowledge of music, the Guide to Understanding Music can expand and enrich that knowledge. If you've always wanted to understand music but have been discouraged because it looked too difficult and time-consuming, the Guide to Understanding Music can show you how easily and quickly you can make yourself at home with any music.

This exclusive four-disc recording is just \$21.98 Postpaid for all four 33 1/3 rpm stereo longplay records, a price made possible by the availability of the consultative and production facilities of Stereo Review and its staff. Under ordinary auspices, a work of this nature and importance would cost much more.

FREE—With each album ordered you'll receive, FREE OF CHARGE, Stereo Review's Stereo Demonstration Record, currently being sold nationally @ \$6.95. This recording is a series of independent sonic demonstrations, each designed to illustrate one or more aspect of musical sound and its reproduction—selected and edited by the editors of Stereo Review.

HERE'S HOW TO ORDER

CASH: Mail your order along with your name, address and remittance in the amount of \$21.98. (Outside U.S.A. \$26.98). Residents of CA, CO, DC, FL, IL, MI, MO, NY STATE, and VT add applicable sales tax.

CHARGE: To your American Express, VISA, Master Charge or Diners Club account! Mail your order, name, address, credit card # and expiration date (Master Charge customers include 4-digit Interbank # above your name). Be sure your signature is on your order. You will be billed at \$21.98.

ORDER FROM: GUM, DEPT. 30009, P.O. BOX 278, PRATT STATION, BROOKLYN, N.Y. 11205

Specify both titles when ordering!

POLY PAKS "SHOP BY MAIL" WITH ITS NEW INFLATION FIGHTIN'

CONTEST PRIZES

SALE *Buy any item on this page and get 2nd item of the same cat. no. for only one penny!

1-LASER OPTO COUPLER, type H11C3, mini dip, (#5700)	1.29	2 for 1.30
3-LINE CORDS, 6 ft. 18 gauge, 2 cond., white w/RC, (#3787)	1.29	6 for 1.30
15-SINGLE PIN MICRO RED LEDS, 100% material, 3 volts @ 10 mls, (#5896)	1.29	30 for 1.30
40-FEEDTHRU CAPACITORS, used for hams, RF, UHF circuitry, (#5847)	1.29	80 for 1.30
40-PLASTIC TRANSISTORS, ass'td untested and hobby, (#2604A)	1.29	80 for 1.30
6-5V INDICATORS, w/leads, test lamp manufacturers excess, (#5893)	1.29	12 for 1.30
40-METAL CAN TRANSISTORS, ass'td types, hobby, untested, (#2603A)	1.29	80 for 1.30
10-UPRIGHT ELECTRODS, 100% ass'td values and voltages, (#5900)	1.29	20 for 1.30
40-SEMI-CON SUPPLIES, zeners, rectifiers, transistors, etc. U-test, (#2226)	1.29	80 for 1.30
65-STABITORS, axial, for regulators & computers, U-Test, (#3140)	1.29	130 for 1.30
40-SQUARE PC COILS, uprights, assorted values, for PC applications, (#3188)	1.29	80 for 1.30
50-1 WATT ZENERS, 3.3, 6.1, 10, 12, 15V, etc., double plug, untested, (#1964)	1.29	100 for 1.30
4-ROCKER SWITCHES, DPDT, solder eyelet terminals, (#3302)	1.29	8 for 1.30
60-LONG LEAD DISCS, 100% prime, marked capacitors, (#5899)	1.29	120 for 1.30
6-MINI TRANSFORMERS, ass'td outputs, interstage & audio, 1" sq., (#3295)	1.29	12 for 1.30
1-TV/AUDIO SHIELDED CABLE, 2 cond. 15 ft. w/RC phone plugs, (#5812)	1.29	2 for 1.30
1-VOICE ENTRY KEYCAPS, 1/4" sq. & 5/8" & functions, ass'td colors, (#4013)	1.29	50 for 1.30
2-GE 3W AUDIO AMP, type PA-263 IC chip, mono, (#1522)	1.29	4 for 1.30
1-MERCURY TILT SWITCH, N.C. rated 24VDC @ .05A, w/leads, (#5686)	1.29	2 for 1.30
6-POWER TAB TRIACS, 100% prime, 100V, TO-220, (#5888)	1.29	12 for 1.30
6-POWER TAB SCR's, 100% prime, 100V, TO-220, (#5904)	1.29	12 for 1.30
2-WATCH LCD'S, 3 1/2 digit, ass'td types, size: 1" x 1 1/2" (approx.), (#5066)	1.29	4 for 1.30
4-TV INTERLOCK JACKS for TV power mt. ctr. solder tab terms., (#5519)	1.29	8 for 1.30
4-MOS FETS, 2N128, by Fairchild & RCA, TO-18, some duals, (#1566)	1.29	8 for 1.30
4-PHOTO ELECTRIC DARLINGTON TRANSISTORS, 2N5777, (#3276)	1.29	8 for 1.30
6-AC "UTILITY" OUTLETS, for 110V mt. ctr. solder lugs, (#3582)	1.29	12 for 1.30
15-NE-2 LAMPS, neon red, for 110VAC, less resistor, (#1435)	1.29	30 for 1.30
20-IN4148 SWITCHING DIODES, 4N5, 100V @ 10mA, axial 100%, (#3000)	1.29	40 for 1.30
2-AMP SILICON BRIDGE RECTIFIER, 200V, block style, (#5928)	1.29	4 for 1.30
4-VARACTOR DIODES, var. tuner capacitance, 200 pf., (#5887)	1.29	8 for 1.30
50-PRECISION RESISTORS, 1/4, 1, & 2 watts, 1%, assorted types, (#363)	1.29	100 for 1.30
60-CERAMIC CAPS, ass'td val. & styles, incl: tubulars, NPO's, etc., (#590)	1.29	120 for 1.30
25-PLASTIC SCR's, incl: 200V, untested, high yield, TO-92, (#329)	1.29	80 for 1.30
40-MOLDED CAPACITORS, tubular, ass'td volt. to 1 mfd. axial leads, (#48642)	1.29	80 for 1.30
60-MICRO ZENER & RECT. KIT, ass'td voltages, only 1/8" sq. U-test, (#1251)	1.29	120 for 1.30
1-LINE CORD, 8 ft. 2 cond. 16 gauge, vinyl molded plug & grommet, (#3661)	1.29	2 for 1.30
16-SPOT MICRO SLIDE SWITCH, only 3/7" cube, for PC mount, (#3429)	1.29	12 for 1.30
10-PR-RC PLUGS & JACKS, for audio, speakers, etc., (#402)	1.29	20 for 1.30
5-2N3055 HOBBY TRANSISTORS, 100%, TO-3, (#3771)	1.29	10 for 1.30
10-ZENERS, 1 watt 9.1 volts axial leads 100% (#5370A)	1.29	20 for 1.30
40-IN4148, 4 NANO, SWITCHING DIODE, axial leads untested (#5923)	1.29	80 for 1.30
2-RELAYS, BACOAC 5VDC, SPST, plastic case, (#5807)	1.29	4 for 1.30
1-25 AMP BRIDGE RECTIFIER, 50 volts, 100% (#5948)	1.29	2 for 1.30
2-QUADRACS, 10 amp 200 PRV, TO-220 100% (#5915)	1.29	4 for 1.30
60-MINI RESISTORS, 30-1/2W, 30-1/4 watt, axial, color coded, (#5922)	1.29	120 for 1.30
12-SCRS-TRIAC-QUADRACS, ass'td volts. TO-220 case (#2087)	1.29	24 for 1.30
10-BULLETPR, ass'td resistor/capacitor networks, various styles, (#5880)	1.29	20 for 1.30
2-AIR TRIMMER CAPS, alum. plates, 1/4" shaft, panel mt. solder lugs, (#5658)	1.29	4 for 1.30
30-MOLEX CONNECTORS, nylon, ass'td styles, colors, & # of cond., (#5835)	1.29	60 for 1.30
1-3 COND. LINE CORD, 8 ft. flat, w/ring terminals, 2 AC, 1 GND, (#5703)	1.29	2 for 1.30
4-12 VOLT LAMPS, w/leads, popular terminal, 100's of uses, (#5942)	1.29	8 for 1.30
25-TTL IC's, untested, ass'td gates, flip flops, etc. 14-16 pin, (#5855)	1.29	50 for 1.30
20-1000 PIV GLASS AMPS, micro-mini, axial, silicon, rated @ 1A, (#5903)	1.29	40 for 1.30
1-12 VCT 200 mA TRANSFORMER, 115 V prim, PC mount, (#5977)	1.29	2 for 1.30
20-400 mW 15V ZENERS, micro-style, ass'td epoxy & glass, 100%, axial, (#5914)	1.29	40 for 1.30
100-UNMARKED CAPS, popular values, mylar & polystyrene, 100%, (#5892)	1.29	200 for 1.30
60-ONE WATT ZENERS, assorted voltages, glass pak, dbl plug, U-test, (#5947)	1.29	120 for 1.30
50-MICRO ZENERS, 1 watt, 2-30V, DO-7 & micro epoxy, axial, 100%, (#5905)	1.29	100 for 1.30
500pc-HARDWARE SURPRISE, ass'td screws nuts & washers, (#5891)	1.29	1000 for 1.30
60-GLASS AMPS, up to 1KV, 1N4000 series, glass encased, untested, (#5982)	1.29	120 for 1.30
200-PC BOARD PARTS, boards loaded w/100% parts, hobby bonanza, (#5946)	1.29	400 for 1.30
6-RF NPN TRANSISTORS, type-2N1059, BVcho: 40V, TO-22, 100%, (#5895)	1.29	12 for 1.30
2-BRASS DOOR LOCKS, w/key, for doors windows, etc. 2-1/8" mt. ctr., (#5949)	1.29	4 for 1.30
1-PUSH-PUSH CB SWITCH, DPDT, 1 x 1/4 x 3/8", 100's of uses, (#3463)	1.29	2 for 1.30
30-"CRIMP-ON" TERMINALS, rings and spades, for # 12-20 wire, (#3955)	1.29	60 for 1.30
5-CALCULATOR KEYBOARDS, multi-function, 17 keys and up, (#3774)	1.29	10 for 1.30
50-ONE-WATT RESISTORS, popular assort, some 5W's, 100's of uses, (#3844)	1.29	100 for 1.30
50-METALLIC FILM 1/2 WATERS, ass'td values, marked, axial leads, (#1605)	1.29	100 for 1.30
4-RIBBON CABLE CONNECTOR, single-sided, 9 contacts, PC leads, (#5967)	1.29	8 for 1.30
3-"SUPER" 2N2222's, NPN, ICBO: 60V, hfe: 100 1W @ 2A, TO-92, 100%, (#5952)	1.29	6 for 1.30
1-12 VDC MINI BLOCK RELAY, spdt, 1 x 3/4 x 5/8", 175 ohm, 1A, (#5937)	1.29	2 for 1.30
10-1.5V GRAIN-O-WHEAT LAMPS, 5/16", w/10" leads, lens: RED, (#6002)	1.29	20 for 1.30
10-IF-FM OP AMPS, by RCA, FM-UHF circuitry, TO-5, 10 leads, (#5951)	1.29	20 for 1.30
10-NPN SWITCHING TRANSISTORS, ass'td gen. audio & switching, (#2595)	1.29	20 for 1.30
1-12 VDC SOLENOID, similar to Guardian 16-p, w/plunger, 1/4" stroke, (#6015)	1.29	2 for 1.30

10-HUMBUCKER CONTROLS W/KNOB, for TV vertical, horiz., etc., (#5882)	1.29	20 for 1.30
50-CAPACITOR SPECIAL, discs, mylar, and more, (#3775)	1.29	100 for 1.30
4-HOBBY VOLTAGE REGULATORS, LM-309, 320, 340's, TO-3, (#3330A)	1.29	8 for 1.30
12-PANEL SWITCHES, assorted slides, rotaries, modulars, etc., (#295)	1.29	24 for 1.30
60-RESISTOR SPECIAL, 1/4 to 1 watt, carbons, carbo-films, etc., (#35896)	1.29	120 for 1.30
6-LM340T VOLTAGE REGULATORS, 5 to 24 volts, TO-220, (#5897)	1.29	12 for 1.30
40-POLYSTYRENE CAPACITORS, ass'td values and voltages, (#1052)	1.29	80 for 1.30
15-THERMISTORS, resistors that change with the temperature, (#2048)	1.29	30 for 1.30
65-1/2 WATT RESISTORS, ass'td values, metal film, marked, (#5797)	1.29	130 for 1.30
1-12VDC SPDT RELAY, 180 ohm coil, 25 mA, 1x1x1 1/2", (#5937)	1.29	2 for 1.30
15-VOLUME CONTROLS, ass'td values, audio, and switch tool, (#592)	1.29	30 for 1.30
60-PRE-FORMED DISC CAPS, handy assortment of values, marked, (#1811)	1.29	120 for 1.30
10-AXIAL ELECTRODS, assorted values and capacitance, (#5907)	1.29	20 for 1.30
5-MULTI-DIGIT LED READOUTS, bubble magnifier, 2 to 6 digits, (#5889)	1.29	120 for 1.30
10-PC TRIMPOTS, screwdriver adjust, assorted values, (#3346)	1.29	20 for 1.30
25-4" CABLE TIES, plastic, like Ty-wrap style, (#5217)	1.29	50 for 1.30
5-CRYSTALS, may include: CB, ham various shapes and sizes, (#5716)	1.29	10 for 1.30
40-POWER RESISTORS, assorted types, includes 2 to 10 watters, (#5228)	1.29	80 for 1.30
40-TWO WATT RESISTORS, carbo-films, carbons, some 5W's, (#456)	1.29	80 for 1.30
50-THERMAL STRIPS, ass'td solder and screw types, 2 lugs & up, (#334)	1.29	100 for 1.30
1-WATCH GUNS, LED, who knows how good, micro-digital bonanza, (#5115)	1.29	2 for 1.30
10-1000V 1A RECTIFIERS, 1N4007, epoxy case, axial leads, (#5926)	1.29	20 for 1.30
5-MULTI-DIGIT LED READOUTS, bubble magnifier, 2 to 6 digits, (#5884)	1.29	10 for 1.30
10-POWER TAB TRANSISTORS, NPN, plastic, TO-220, (#5629)	1.29	20 for 1.30
6-PRECISION TRIM POTS, ass'td singles and multi-turns, untested, (#3389)	1.29	12 for 1.30
50-1N4000 RECTIFIERS, epoxy, axial leads, untested, (#2594)	1.29	100 for 1.30
30pc-HEAT SHRINK, Thermo-fit, useful ass'td of sizes, shrinks 50%, (#5248)	1.29	60 for 1.30
10-SLIDE SWITCHES, SPST, SPDT, etc. all shapes and sizes, (#5927)	1.29	20 for 1.30
25-DT's, 100% prime, ass'td flip flops, etc., marked, (#3709)	1.29	50 for 1.30
4-HOBBY OPTO COUPLERS, 1500 VOLT ISOLATION, U-test, (#2629A)	1.29	8 for 1.30
8-TAPE RECORDER EARPHONE, for radios, recorders, 8 ohms, (#2946)	1.29	16 for 1.30
5-MICRO MINI JACKS, in a block, for 2mm sub-mini plugs, (#1437)	1.29	10 for 1.30
1-PL-55 PHONE JACKS, standard bushing, for hams, communications, (#5868)	1.29	10 for 1.30
40-RED DEVIL CAPACITORS, handy assort. of pop. values, axial leads, (#3023)	1.29	80 for 1.30
50-MICAS ass'td sizes-n-shapes, incl. "silvers" too! (#373)	1.29	100 for 1.30
10-TRANSISTOR SOCKETS, for npn and pnp types, (#5944)	1.29	20 for 1.30
12-LED DRIVER IC's, similar to 75491, (#5890)	1.29	24 for 1.30
10-MODULAR SWITCHES, Centralab "push-on" type, up to 8PDT, (#3150)	1.29	20 for 1.30
5-"MOTOR MOTORS", small, high speed, ass'td sizes, 3-6VDC, (#2551)	1.29	10 for 1.30
2-HEAVY DUTY LINE CORDS, 8 ft., 2 cond., 18 gauge, black insulation, (#5803)	1.29	4 for 1.30
10-LED SOCKETS, "snap-in" mini, for LEDs, ass'td values, (#5748)	1.29	100 for 1.30
10-MV-54 MICRO-MINI LEDS, flat top style, diffused red lens, (#1789)	1.29	20 for 1.30
30-WIRE NUTS, twist-on's, for #20-24 gauge wire, (#3724)	1.29	60 for 1.30
2-ALUM. HEAT SINKS, 2 1/2"x3", for power tabs, innumerable uses, (#5338)	1.29	4 for 1.30
1-"MICRO MINI" METER, 1/2" dia. 0-1 basic movement, (#5858)	1.29	2 for 1.30
2-DUBBLE-SIDED PC BOARDS, 3"x12" high quality G-10 glass, (#5694)	1.29	4 for 1.30
60-TUBULAR CAPACITORS, ass'td 100mm to 1mt to 600 WVDC, (#35219)	1.29	120 for 1.30
60-MICRO MINI REED SWITCHES, 1" long, for alarms, relays, etc., (#1258)	1.29	12 for 1.30
10-TANTALUM ELECTRODS, ass'td mini, axial, hermetically sealed, (#5848)	1.29	20 for 1.30
60-DISC TYPE CAPS, incl: NPO, hi-mylar, mylar, ceramics, ass'td values, (#437)	1.29	100 for 1.30
60-COILS & CHOKES, ass'td RF, OSC, IF, parasitic types, (#35297)	1.29	120 for 1.30
6-SWITCHCRAFT PHONO JACKS, hi-Q, chassis mount, teflon base, (#5119)	1.29	12 for 1.30
1-TO-3 HEAT SINK, heavy duty aluminum, prepunched for TO-3, (#4083)	1.29	2 for 1.30
65-MOLEX SOCKETS, "on-a-strip", for multiple pin dips, (#1609)	1.29	130 for 1.30
6-PAIRS 9V BATTERY CLIPS, w/red & black color-coded leads, (#2852)	1.29	12 for 1.30
1-UHF TUNER, 3 gang, uhf tv unit, 300 ohm, pos. direct drive, (#2927)	1.29	2 for 1.30
15-HUMBUCKER CONTROLS, assorted values, manufacturers dump, (#3807)	1.29	30 for 1.30
30-SUBMINI IF TRANSFORMERS, slug tuned, shielded, (#3549)	1.29	60 for 1.30
5-"PROP" OPTICAL LENSES, 1" dia., plastic, (#5043)	1.29	20 for 1.30
40-ADJUSTABLE FERRITE CORES, center cut for hex adjust, (#5701)	1.29	80 for 1.30
3-1.5V MINI BATTERIES, only 3/32" dia., draws 15mA, w/1" wire leads, (#5693)	1.29	6 for 1.30
30-FT. WIRE-WRAP WIRE, 30 gauge, insulated, continuous length, (#3803)	1.29	60 for 1.30
4-MONO TAPE HEADS, may incl: cassette, 8-track, reel to reel too! (#5769)	1.29	8 for 1.30
5-DUAL DIGIT "BUBBLE" READOUTS, HP5082 style, red, dip style (#5748)	1.29	10 for 1.30
40-METAL & PLASTIC TRANSISTORS, ass'td sizes (#1965)	1.29	80 for 1.30
2-HI PWR. TRANSISTORS, Motorola type, MJ3201, NPN 15W, TO-66, (#2797)	1.29	4 for 1.30
60-GERM. GLASS DIODES, similar to TN34, axial leads, untested, (#642)	1.29	120 for 1.30
40-IN574 SWITCHING DIODES, silicon, 4N5, glass, untested, (#5748)	1.29	60 for 1.30
4-ANFM VARIABLE COND., 2 bands, "poly-mylar" 3/4" square, (#2924)	1.29	8 for 1.30
3-MICRO SWITCHES, SPST, NO contacts, plunger style, solder tabs, (#5785)	1.29	6 for 1.30
10-MULTI-GANG POTS, audio 2 gangs and up, ass'td types and values, (#5326)	1.29	20 for 1.30
10-MAN-3's, 7 segment, w/bubble magnifier, 100% material, (#3842)	1.29	20 for 1.30
3-PL-259 COAX PLUG, mates to SO-239, Amphenol, (#5221)	1.29	6 for 1.30
1-LITE SENSITIVE UNIJUNCTION TRANSISTOR, programmable, (#5719)	1.29	2 for 1.30

FANTASTIC! YOU BET IT IS! LOOK WHAT YOU GET FOR 1c MORE!

"TIE-PIN" 2 for \$3.98

CONDENSER MIKE

It's a little giant in sound quality! Metal encased, and omnidirectional! Frequency response 20-20,000 Hz! Less tie pin or lapel clip! 600 ohm impedance. 15 VDC. Cat. No. #730

\$3.95

25 AMP BRIDGE RECTIFIERS

PIV	SALE	2 FOR
25	1.28	2.58
50	1.98	3.98
100	2.28	4.58
200	2.98	5.98
400	3.50	6.98

Order by Cat. No. 2273 & voltage

HOW TO ORDER

When ordering, always use catalog number, type no., the name of the magazine you are ordering from and the month.

HY - GAIN ONE ARM BANDIT MIKES

Only **\$14.99**

2 FOR \$15

Take one hand command of your mobile or base rig with Hy-Gain's One Arm Bandit Mike. ON VOLUME, SQUELCH, CHANNEL SELECTOR, SPEAKER, and DIGITAL DISPLAY are all conveniently located where your fingers do the talking. Comes with 6 ft. multi-conductor, color-coded, color cable, (separate) for easy integration into any type of rig. Size: 4 1/4" x 2 1/4" x 1 1/4". Wt. 9 oz. No. 92CU5886

40 CHANNEL CB ON A BOARD

\$12.50 2 FOR \$12.51

Poly Pak buys up factory close-out from Hy-Gain... so 28! Gain! Boards have: Heatsinked 9 Watt Amp Chip, RF and Mod. Transistors, and Motorola MC series PL. May be used for 10 meter conversion, (see continuing series "CB to 10" in 73 magazine). The parts alone make it an offer you can't refuse. Wt. 9 oz. No. 92CU5554

WITH SWITCH

ULTRASONIC TRANSDUCER

\$3.98 2 for \$3.99

Perfect for dozens of projects, including remote control devices, alarms, etc. Sends and Receives! 1" diameter, 3/4" deep, with standard RCA type phone jack. Wt. 2 oz. Cat. No. 92CU5375

"SKINNY-TRIMS" POTENTIOMETERS

3/8" square! Single turn style! Screw driver adjust! 20% tolerance. 0.5 Watt ratings! ceramic construction! PL leads! ORDER BY CAT. NO. AND VALUE

TYPE-63	SINGLE TURN FLAT
10 100 1K 10K 25K 500K	10 100 1K 10K 25K 500K
20 200 2K 20K 50K 500K	20 200 2K 20K 50K 500K
50 500 2.5K 20K 100K 1Meg	50 500 2.5K 20K 100K 1Meg

6 for \$2.49 12 for \$2.50

POLY PAKS®

COD'S MAY BE PHONED!

P.O. BOX 942-E10
SO. LYNNFIELD, MA
01940

Terms: Add Postage Rated: Net 30
Phone: (617) 245-3828
Retail: 16-18 Del Carmine St.
MINIMUM ORDER: \$8 Wakefield, MA

LED'S! LED'S! LED'S!

YOUR CHOICE 5 for \$1.29
10 SALE 10 for \$1.30

Cat. No.	Type
1788	MICRO TOPHAT RED
1802	MICRO RINGLED PIN RED
1948	MICRO YELLOW
2135	JUMBO RED
2136	JUMBO TAPER RED
2137	MICRO RED
1944	Jumbo Yellow
2138	Jumbo Green

1N4000 Epoxy Rectifiers

Cat. No.	Type	Volts	Size	1c SALE:
2377	1N4001	50	10 for	\$.75 20 for \$.76
2378	1N4002	100	10 for	\$.85 20 for \$.86
2379	1N4003	200	10 for	\$.95 20 for \$.96
2380	1N4004	400	10 for	\$ 1.10 20 for \$ 1.20
2381	1N4005	600	10 for	\$ 1.30 20 for \$ 1.40
2382	1N4006	800	10 for	\$ 1.49 20 for \$ 1.50
2383	1N4007	1000	10 for	\$ 1.59 20 for \$ 1.60

\$12.50 2 for \$12.51

DIAL DESK TELEPHONE

less bell and control



Super Basic on Cassette

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A IK Super ROM Monitor \$19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of

TERMS: \$5.00 min. order U.S. Funds. Calif residents add 6% tax.
BankAmericard and Master Charge accepted.
Shipping charges will be added on charge cards.

Tiny Basic Cassette \$10.00, on ROM \$38.00
original Elf kit board **\$14.95.**

The **Power Supply Kit** for the Super Expansion Board is a 5 amp supply with multiple positive and negative voltages \$29.95. Add \$4.00 for shipping. **Prepunched frame** \$7.50. **Case** \$10.00. Add \$1.50 for shipping.

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, IC, crystal, resistors, capacitors and trimmer.

7400TL	17	LM317	2.82	D40115	86	
7402N	17	LM320K-5	1.35	D40116	86	
7402N	17	LM320K-5	1.20	D40117	86	MEMO
7402N	19	LM320K-5	1.35	D40118	94	
7403N	23	LM320K-12	1.35	D40119	98	RAM
7410N	17	LM320K-5	1.35	D40120	86	
7412N	83	LM320K-5	1.35	D40121	1.02	2102-1
7422N	139	LM320T-8	1.60	D40122	85	2102A-4
7422N	139	LM320T-12	1.50	D40123	28	
7422N	139	LM320T-15	1.50	D40124	28	
7442N	50	LM324N	1.15	D40125	86	2104A-4
7445N	69	LM338N	1.50	D40126	1.51	2107A-5
7445N	69	LM338N	1.50	D40127	1.51	2111-1
7448N	69	LM338N-6	1.35	D40128	78	2112-2
7450N	17	LM340K-12	1.35	D40129	1.02	2114-1
7450N	17	LM340K-12	1.35	D40130	1.02	4116
7478N	49	LM340K-24	1.35	D40131	1.02	23138
7485N	88	LM340T-5	1.50	D40132	1.92	MM5280
7485N	88	LM340T-5	1.50	D40133	1.92	MM5280
7485N	88	LM340T-5	1.50	D40134	1.92	MM5280
7485N	88	LM340T-12	1.25	D40135	1.92	MM5280
7485N	88	LM340T-12	1.25	D40136	1.92	MM5280
7485N	88	LM340T-12	1.25	D40137	1.92	MM5280
7485N	88	LM340T-12	1.25	D40138	1.92	MM5280
7485N	88	LM340T-12	1.25	D40139	1.92	MM5280
7485N	88	LM340T-12	1.25	D40140	1.92	MM5280
7485N	88	LM340T-12	1.25	D40141	1.92	MM5280
7485N	88	LM340T-12	1.25	D40142	1.92	MM5280
7485N	88	LM340T-12	1.25	D40143	1.92	MM5280
7485N	88	LM340T-12	1.25	D40144	1.92	MM5280
7485N	88	LM340T-12	1.25	D40145	1.92	MM5280
7485N	88	LM340T-12	1.25	D40146	1.92	MM5280
7485N	88	LM340T-12	1.25	D40147	1.92	MM5280
7485N	88	LM340T-12	1.25	D40148	1.92	MM5280
7485N	88	LM340T-12	1.25	D40149	1.92	MM5280
7485N	88	LM340T-12	1.25	D40150	1.92	MM5280
7485N	88	LM340T-12	1.25	D40151	1.92	MM5280
7485N	88	LM340T-12	1.25	D40152	1.92	MM5280
7485N	88	LM340T-12	1.25	D40153	1.92	MM5280
7485N	88	LM340T-12	1.25	D40154	1.92	MM5280
7485N	88	LM340T-12	1.25	D40155	1.92	MM5280
7485N	88	LM340T-12	1.25	D40156	1.92	MM5280
7485N	88	LM340T-12	1.25	D40157	1.92	MM5280
7485N	88	LM340T-12	1.25	D40158	1.92	MM5280
7485N	88	LM340T-12	1.25	D40159	1.92	MM5280
7485N	88	LM340T-12	1.25	D40160	1.92	MM5280
7485N	88	LM340T-12	1.25	D40161	1.92	MM5280
7485N	88	LM340T-12	1.25	D40162	1.92	MM5280
7485N	88	LM340T-12	1.25	D40163	1.92	MM5280
7485N	88	LM340T-12	1.25	D40164	1.92	MM5280
7485N	88	LM340T-12	1.25	D40165	1.92	MM5280
7485N	88	LM340T-12	1.25	D40166	1.92	MM5280
7485N	88	LM340T-12	1.25	D40167	1.92	MM5280
7485N	88	LM340T-12	1.25	D40168	1.92	MM5280
7485N	88	LM340T-12	1.25	D40169	1.92	MM5280
7485N	88	LM340T-12	1.25	D40170	1.92	MM5280
7485N	88	LM340T-12	1.25	D40171	1.92	MM5280
7						

8K Static RAM Kit	Godbout	\$135.00
16K Static RAM Kit		265.00
24K Static RAM Kit		423.00
32K Dynamic RAM Kit		310.00
64K Dynamic RAM Kit		470.00
8K/16K Eprom Kit (less PROMS)		\$89.00
Video Interface Kit		\$139.00
Motherboard	\$39.	Extender Board \$8.99

Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage \$3.50. 1978 IC Master closeout \$19.50. No foreign orders.

Indoor and outdoor. Switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure -100° to +200°F, tenths of a degree, air or liquid. Beautiful woodgrain case/wheel. **\$11.75**

Active Electronic Sales Corp.

Power Transistors

2N3054	.65	60V	NPN
2N3055	.69	70V	NPN
2N3442	1.50	160V	NPN
2N3771	1.95	50V	NPN
2N3772	1.95	100V	NPN
2N3773	2.50	160V	NPN
TIP29	.50	1A 60V	NPN
TIP30	.50	1A 60V	PNP
TIP31	.55	3A 60V	NPN
TIP32	.55	3A 60V	PNP
TIP41	.98	6A 60V	NPN
TIP42	1.10	6A 60V	PNP
TIP115	.85	2A 60V	PNP
TIP125	.85	5A 60V	PNP
TIP127	.95	5A 100V	PNP
TIP2955	1.10	15A 60V	PNP
TIP3055	.92	15A 60V	NPN

SCR

CI06D .34 5.0 AMP 400V TO-220

MICROPROCESSOR CHIP SETS

Part No.	Price	Part No.	Price
8080A	6.95	6800	6.95
8085	12.95	6802	11.95
8212	3.45	6810	3.95
8214	3.95	6820	3.95
8216	3.25	6821	3.95
8224	2.95	6850	4.25
8226	2.25	6852	3.95
8228	3.98	SCP1802LE	9.95
8238	4.75	SCP1824LE	3.50
8251	5.75	SCP1852LE	1.50
8253	14.95	SCP1853LE	1.45
8255	5.75	SCP1854LE	6.95
8257	10.95	SCP1856LE	1.95
8259	14.95	SCP1858LE	1.95
		SCP1859LE	1.50

EPROM'S

1702A-6	\$6.95	\$4.45
256 x 8 1.5 uS		
2708		\$9.95
1K x 8 450 NS		
2716/TMS2516		\$49.95
16K (2K x 8) 450NS		
(1 power supply - Intel version)		
TMS2716		\$34.95
16K (2K x 8) 450NS (3 power supplies)		

MOS Static RAM's

Part No.	Price
2101	\$2.39 \$1.98
1K 22 PIN	
2102LFPC	\$1.19
1K 350NS (Low Power)	
2102-1PC	\$3.99 0.94
1K 450NS	
2114	\$6.75 \$5.99
4K (1K x 4) 300NS	

MOS Dynamic RAM's

Part No.	Price
4K 4027	\$2.95
4K (4K x 1) 300NS 16 PIN	
16K 416-3	\$12.95
16K(16Kx1) 200NS 16PIN	
16K 416-5	\$10.95
16K(16Kx1) 300NS 16PIN	

UART's

Part No.	Price
AY5-1013A	\$4.50 \$4.25
AY3-1015	\$5.50 \$5.25

1K CMOS RAM

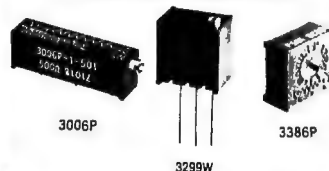
Part No.	Price
5101	\$4.50 \$3.95
450NS (Low Power)	



POTENTIOMETERS TRIMPOT® Potentiometers

MODEL	POWER	STANDARD RESISTANCES	DIMENSIONS (H x W x L)	PRICE
3006P	0.75 Watt	10 ohm - 2 Meg	25" x 19" x 75"	\$0.80
3299W	0.5 Watt	10 ohm - 1 Meg	39" x 37" x 25"	\$1.42
3386P	0.5 Watt	10 ohm - 2 Meg	375" x 375" x 19"	\$0.60

P = Printed Circuit Pins (flat mounting)
W = Printed Circuit Pins (edge mounting)



Z80-CPU	\$9.95	Z80-CTC	\$7.95
Z80A-CPU	\$11.95	Z80A-CTC	\$8.95
Z80-DMA	\$24.95		
Z80-SIO/0	\$35.00		
Z80A-SIO/0	\$45.00		
Z80-SIO/1	\$35.00		
Z80A-SIO/1	\$45.00		
Z80-SIO/2	\$35.00		
Z80A-SIO/2	\$45.00		

1979 IC MASTER

Complete integrated circuit data selector. Master guide to the latest I.C.'s including microprocessors and consumer circuits.

~~\$33.95~~

Free Quarterly Updates

2500 pages

"New Special Low Price"

\$29.95

L.E.D. LAMPS

LED209	T-1 3mm Red	.09
LED211	T-1 3mm Green	.14
LED212	T-1 3mm Yellow	.13
LED220	T-1 3/4 5mm Red	.11
LED222	T-1 3/4 5mm Green	.15
LED224	T-1 3/4 5mm Yellow	.14



DISPLAYS

MAN74A	.300"	Common Cathode	\$0.99
FND357	.375"	Common Cathode	\$1.09
FND500	.500"	Common Cathode	\$1.09
FND507	.500"	Common Anode	\$1.09
FND567	.500"	Common Anode	\$1.29
DL747	.630"	Common Anode	\$2.30
DL704	.300"	Common Cathode	\$1.29
DL707	.300"	Common Anode	\$1.29

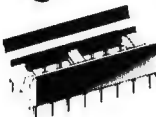
ISOLATORS

IL1	Opto Coupler	1500V	.49
4N26	Opto Isolator	2500V	.59
MCT6	Dual Opto Isolator	1500V	\$1.29

Texas Instruments Low Profile Sockets

Over one million pieces in stock.

Contacts	Price	Contacts	Price
8 PIN	.08	22 PIN	.22
14 PIN	.12	24 PIN	.24
16 PIN	.14	28 PIN	.28
18 PIN	.18	40 PIN	.40
20 PIN	.20		



VOLTAGE REGULATORS

7800UC Series	Positive 1 AMP
(TO-220 Plastic)	5, 6, 8, 12, 15, 18, 24, Volts
	\$0.99

Data Available on Request

High Current (TO-3)

78H05SC	\$4.92	5V/5A
78H12SC	\$5.07	12V/5A
78H15SC	\$5.07	15V/5A
78P05SC	\$7.56	5V/10A
78HGKC	\$5.75	5V-24V/5A Positive Adjustable
79HGKC	\$8.32	- 24V to 2.11V/5A Negative Adjustable
SH1605	\$12.22	3V-30V/5A Adj. Step Down Switching
SH1705	\$7.56	5V/5A Fixed Positive

Prices in this ad are valid only until Oct. 31, 1979



Active Electronic Sales Corp.

P.O. BOX 1035 FRAMINGHAM, MASSACHUSETTS 01701

Over-the-counter sales.
12 Mercer Rd., Natick, Mass 01760
Behind Zayres on Rte. 9
Telephone Orders & Enquiries (617) 879-0077

IN CANADA

5651 FERRIER ST.
MONTREAL, QUEBEC
H4P 2K5
Tel: (514) 735-6425

4800 DUFFERIN ST.
DOWNSVIEW, ONTARIO
M3H 5S9
Tel: (416) 661-1115

MINIMUM ORDER \$10.00 • ADD \$2.00 TO COVER POSTAGE & HANDLING

Foreign customers please remit payment on an international bank draft or international postal money order in American dollars.

BAXTER CENTRE
1050 BAXTER ROAD
OTTAWA, ONTARIO
K2C 3P2
Tel: (613) 820-9471

3070 KINGSWAY
VANCOUVER, B.C.
V5R 5J7
Tel: (604) 438-3321



Radio Shack — Your No. 1 Parts Place™

Low Prices and New Items Every Day!

Low-Power Schottky ICs

Low As

49¢



- 100% Prime
- Guaranteed Specs

Improved 5-volt logic devices use Schottky diode technology for minimum propagation delay and high speed at minimum power.

Type	Cat. No.	ONLY
74LS00	276-1900	.49
74LS02	276-1902	.59
74LS04	276-1904	.59
74LS08	276-1908	.49
74LS10	276-1910	.59
74LS13	276-1911	.99
74LS20	276-1912	.59
74LS27	276-1913	.69
74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
74LS74	276-1919	.69
74LS75	276-1920	.99
74LS76	276-1921	.79
74LS85	276-1922	1.29
74LS90	276-1923	.99
74LS92	276-1924	.99
74LS93	276-1925	.99
74LS123	276-1926	1.19
74LS132	276-1927	.99
74LS151	276-1929	.99
74LS157	276-1930	1.19
74LS161	276-1931	1.49
74LS164	276-1932	1.49
74LS175	276-1934	1.19
74LS192	276-1935	1.49
74LS193	276-1936	1.49
74LS194	276-1937	1.49
74LS196	276-1938	1.59
74LS367	276-1835	1.19
74LS368	276-1836	1.19
74LS373	276-1943	2.39
74LS374	276-1944	2.39

4000-Series CMOS ICs

Type	Cat. No.	EACH
4001	276-2401	.69
4011	276-2411	.69
4012	276-2412	.79
4013	276-2413	.99
4017	276-2417	1.69
4020	276-2420	1.69
4021	276-2421	1.69
4023	276-2423	.69
4027	276-2427	.99
4028	276-2428	1.29
4046	276-2446	1.89
4511	276-2447	1.69
4049	276-2449	.79
4050	276-2450	.79
4051	276-2451	1.49
4066	276-2466	1.39
4070	276-2470	.79
4518	276-2490	1.49
4543	276-2491	1.99

All Prime from Major Semiconductor Manufacturers. Specs and Pin Out Diagram Included with Each Device.



NEW!

NEW!

Low As
2⁹⁵

Need Info? — Find it
at Radio Shack!

- A** Motorola RF Data Manual. Power and small-signal RF transistors, hybrid amplifier modules, more. 62-1380 4.95
B Motorola Low-Power Schottky TTL. Data and diagrams plus selection guide for choosing best device. 62-1381 3.95
C Linear Applications, Vol. 2. Latest data, diagrams, applications briefs and articles. Indexed. 62-1374 2.95
D CMOS Integrated Circuits. Covers 74C, CD4000-series with complete data, diagrams. Cross referenced. 62-1375 3.95
E Memory Data Book. Complete info on MOS and bipolar memory components, support circuits. 62-1376 3.95

Archer® Semiconductor Reference Handbook

NEW! 1⁹⁹

Available Only at
Radio Shack!

A complete guide to Radio Shack's line of high-quality solid-state devices. Cross reference and substitution guide for over 100,000 types. Pin outs, detailed data for ICs, diodes, LEDs, SCRs, displays and more! 224 pages. 276-4003 Only 1.99



SN-76477 "Sound and Music Synthesizer" IC

2⁹⁹



Combines Linear and PL Technology
on a Single Chip of Silicon!

Creates almost any type of sound — from music to explosions and "gunshots!" High level op amp output. Includes 2 VCOs, low frequency osc., noise generator, filter, 2 mixers, timing logic. 28-pin DIP. With data. For 9VDC. 276-1765 2.99

3 Hall-Effect Sensors

NEW!

1⁹⁸ Pkg.
of 3

Open-Collector Output

Detects magnetic fields electronically. 750 gauss "on" threshold. Constant amplitude independent of frequency. Similar to type ULN 3006. Ideal for tachs, position sensing, pulse counting. 5 to 16V supply. TO-92 case. With data. 276-1646 Pkg. of 3/1.98

BIFET Op Amps

NEW!

Low As
1⁸⁹

Feature very high input impedance, low noise. Fast 13V/μs slew rate is ideal for low TIM distortion audio amplifiers. Internally compensated. Up to ± 18V supply.

- A** LF 353N. Dual BIFET Op amp. 8-pin DIP. 276-1715 1.89
B TL 084C. Quad BIFET Op amp. 14-pin DIP. 276-1714 2.99

NEW! 10 Assorted Mini Reed Switches

1⁹⁸ Pkg.
of 10



Hermetically sealed. Gold-plated contacts close when magnetic field is present. Includes mini and micro types. 275-1610 Pkg. of 10/1.98

V to F, F to V Converter

NEW!

3⁴⁹



High Linearity and Accuracy

9400CJ. Accepts analog voltage and generates linear proportional output frequency or provides a voltage output depending on input frequency. Operates either mode up to 100 kHz. With data. 14-pin DIP. 276-1790 3.49

Dual Audio Delay IC

NEW!

10⁹⁵



Variable Electronic Time Delay

SAD1024A. "Bucket Brigade" device has 2 independent 512-stage shift registers to produce echo, reverb, chorus and phase shift effects. 18-pin DIP. With circuits, data. 276-1761 10.95

10-Position BCD Switch

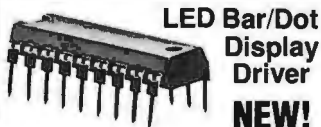
NEW!

2⁹⁹



Contacts Gold-Plated

Full 0-9 binary coded outputs for logic circuits. Eliminates extra encoding circuitry. Positive detents. Fits standard 8-pin DIP socket or mounts on PC board. 275-1310 2.99



LED Bar/Dot Display Driver
NEW!

Ideal for Voltage, Current and Audio Power Displays **3⁴⁹**

LM3914N. Features 10 adjustable analog steps, bar or dot display mode. Current-regulated LED outputs. 8 to 25VDC supply. 18-pin DIP. 276-1707 3.49



4-Digit 0.5" LCD
NEW!
7⁹⁵

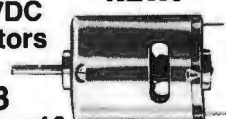
Includes Socket

Easy to read liquid crystal display with snooze, alarm and PM indicators. Direct drive design. Requires 5 VDC at 10 μA. With pin-out data. 276-1230 7.95

Three 12VDC Motors

NEW!

1⁹⁸ Pkg. of 3



High torque, permanent magnet type motors operate up to 10,000 RPM at no load. Shaft diameter: 3/32". Overall length: 1/2". Ideal for hobby projects. 273-213 Pkg. of 3/1.98

**WHY WAIT FOR MAIL ORDER DELIVERY?
IN STOCK NOW AT OUR STORE NEAR YOU!**

Radio Shack®

A DIVISION OF TANDY CORPORATION • FORT WORTH, TEXAS 76102
OVER 7000 LOCATIONS IN 40 COUNTRIES

Prices may vary at individual stores and dealers

Transistor Checker



— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high power PNP and NPN transistors. Size: 3 1/2" x 6 1/4" x 2 1/2". "C" cell battery not included.

Trans-Check \$19.95 ea.

Custom Cables & Jumpers

NEW



NEW

DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 ft.	2-DP25P	\$15.95 ea.
DB25P-4-S	4 ft.	1-DP25P/1-25S	\$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	\$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	\$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS

25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	\$2.95
DB25S	SOCKET (Meets RS232)	\$3.50
DB51226-1	Cable Cover for DB25P or DB25S	\$1.75

PRINTED CIRCUIT EDGE-CARD

.186 Spacing-Inch Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	\$1.95
18/36	PINS (Solder Eyelet)	\$2.49
22/44	PINS (Solder Eyelet)	\$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)	\$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap)	R681-1 \$6.95

4-Digit Clock Kit

- * Bright .357" ht. red display
- * Sequential flashing color
- * 12 or 24 hour operation
- * Extruded aluminum case (black)
- * Pressure switches for hours, minutes & hold functions
- * Includes all components, case and wall transformer
- * Size: 3 1/4" x 1 1/4" x 1 1/4"

JE730 \$14.95

Jumbo 6-Digit Clock Kit

- * Four .630" ht. and two .300" ht. common anode displays
- * Uses MM5314 clock chip
- * Switches for hours, minutes & hold functions
- * Hours easily viewable to 30 feet
- * Simulated walnut case
- * 115 VAC operation
- * 12 or 24 hour operation
- * Includes all components, case and wall transformer
- * Size: 6 1/2" x 3 1/2" x 1 1/2"

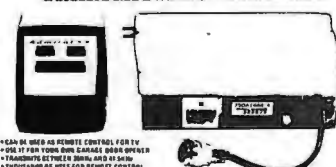
JE747 \$29.95

- * Bright .300 ht. comm. cathode display
- * Uses MM5314 clock chip
- * Switches for hours, minutes and hold modes
- * Hrs. easily viewable to 20 ft.
- * Simulated walnut case
- * 115 VAC operation
- * 12 or 24 hr. operation
- * Incl. all components, case & wall transformer
- * Size: 6 1/2" x 3 1/8" x 1 1/4"

JE701 \$19.95

6-Digit Clock Kit

REMOTE CONTROL TRANSMITTER & RECEIVER



\$19.95

Digital Stopwatch Kit

- * Uses Intersil 7205 Chip
- * Plated thru double-sided P.C. Board
- * LED display (red)
- * Times to 59 min. 59.99 sec. with auto reset
- * Quartz crystal controlled
- * Three stopwatches in one: single event, split (cumulative) & Taylor (sequential timing)
- * Uses 3 penlite batteries
- * Size: 4.5" x 2.15" x .90"

JE900 \$39.95

MICROPROCESSOR COMPONENTS

8080A/8085A SUPPORT DEVICES		MICROPROCESSOR MANUALS	
8080A	CPU	\$ 6.95	
8212	8-Bit Input/Output	3.25	
8214	Priority Interrupt Control	3.50	
8216	Bi-Directional Bus Driver	3.49	
8224	Clock Generator/Driver	3.49	
8226	Bus Driver	3.95	
8228	System Controller/Bus Driver	5.95	
8238	System Controller	5.95	
8251	Prog. Comm. I/O (USART)	7.95	
8253	Prog. Interval Timer	14.95	
8255	Prog. Periph. I/O (PPI)	8.95	
8257	Prog. DMA Control	19.95	
8259	Prog. Interrupt Control	19.95	
8080/8085 SUPPORT DEVICES		MICROPROCESSOR MANUALS	
MC6800	MPU	\$14.95	
MC6802CP	MPU with Clock and Ram	24.95	
MC6810AP	128K Static Ram	2.95	
MC6821	Periph. Inter. Adapt (MC6820)	7.40	
MC6828	Priority Interrupt Controller	12.95	
MC6830LS	1024Kx8 Bit ROM (MC68A30-8)	14.95	
MC6850	Asynchronous Comm. Adapter	7.95	
MC6852	Synchronous Serial Data Adapt.	9.95	
MC6860	4-600 bps Digital MODEM	12.95	
MC6862	2400 bps Modem	14.95	
MC6860A	Quad 3-State Bus Trans (MC68T60)	2.25	
MICROPROCESSOR CHIPS—MISCELLANEOUS		MICROPROCESSOR MANUALS	
Z801780C1	CPU	\$19.95	
Z80A1780-1	CPU	2.95	
CDP1802	CPU	18.95	
2850	MPU	18.95	
6502	CPU	11.95	
6035	8-Bit MPU w/clock, RAM, I/O lines	18.95	
P8085	CPU	19.95	
TMS9900ML	16-Bit MPU w/hardware, multiply & divide	49.95	
SHIFT REGISTERS		MICROPROCESSOR MANUALS	
MM5500H	Dual 25 Bit Dynamic	\$ 5.50	
MM5503H	Dual 50 Bit Dynamic	5.50	
MM5504H	Dual 16 Bit Static	.50	
MM5505H	Dual 100 Bit Static	.50	
MM5510H	Dual 64 Bit Accumulator	.50	
MM5516H	500/512 Bit Dynamic	.80	
2504T	1024 Dynamic	3.95	
2518	Hex 32 Bit Static	4.95	
2522	Dual 132 Bit Static	2.95	
2524	512 Static	2.95	
2526	1024 Dynamic	2.95	
2527	Dual 256 Bit Static	2.95	
2528	Dual 250 Static	4.00	
2529	Dual 240 Bit Static	4.00	
2532	Quad 80 Bit Static	2.95	
2535	1024 Static	2.95	
3341	Fifo	6.95	
74LS670	4Kx4 Register File (TriState)	2.49	
UART'S		MICROPROCESSOR MANUALS	
A-Y-5-1013	30K BAUD	5.95	
MICROPROCESSOR CHIPS—MISCELLANEOUS		MICROPROCESSOR MANUALS	
M-280	User Manual	\$7.50	
M-CDP1802	User Manual	7.50	
M-2850	User Manual	5.00	
ROM'S		MICROPROCESSOR MANUALS	
2513(2140)	Character Generator (upper case)	\$9.95	
2513(3021)	Character Generator (lower case)	9.95	
2516	Character Generator	10.95	
MM5230N	2048-Bit Read Only Memory	1.95	
RAM'S		MICROPROCESSOR MANUALS	
1101	256X1 Static	\$1.49	
1103	1024X1 Dynamic	.99	
2105(10101)	256X1 Static	3.95	
2102	1024X1 Static	1.75	
2102	1024X1 Static	1.95	
2111(18111)	256X4 Static	3.95	
2112	256X4 Static MOS	4.95	
2114	1024X4 Static 450ns	9.95	
2114L	1024X4 Static 450ns low power	10.95	
2114-3	1024X4 Static 450ns	10.95	
2114L-3	1024X4 Static 300ns low power	11.95	
8101	256X4 Static	7.95	
8202	1024X4 Dynamic	4.95	
7489	16X4 Static	1.75	
748200	256X1 Static Tristate	4.95	
93421	256X1 Static	2.95	
UPD414	4K Dynamic 18 pin	4.95	
UPD418	16K Dynamic 18 pin	9.95	
11M4119	4K Static	14.95	
TMS4044	4K Static	14.95	
4801	1024X4 Static	14.95	
TMS4045	16,384X1 Static	9.95	
2117	1024X4 Static	4.95	
MM5262	25X1 Dynamic	4/1.00	
PROM'S		MICROPROCESSOR MANUALS	
1702A	2048 FAMOS	\$5.95	
2710INTEL	16K* EPROM	59.95	
TMS2516	16K* EPROM	49.95	
(2716)	*Requires single -5V power supply	89.95	
TMS2532	4KX8 EPROM	10.95	
2708	8K* EPROM	29.95	
2716 1	16K* EPROM	29.95	
5203	2048 Tristate Bipolar	14.95	
6301-1(7611)	1024 Tristate Bipolar	3.49	
6303-1(7602)	256 Open C Bipolar	2.95	
82533	32X8 Open Collector	3.95	
82515	40X8 Bipolar	19.95	
825123	32X8 Tristate	3.95	
74186	512 TTL Open Collector	9.95	
74188	256 TTL Open Collector	3.95	
745287	1024 Static	2.95	

CONTINENTAL SPECIALTIES

Proto Board 203



Model Number	L x W x H (Inches)	Price
PB-6	6.0 x 4.5 x 1.4	\$15.95
PB-100	6.0 x 4.5 x 1.4	\$18.95
PB-101	6.0 x 4.5 x 1.4	\$22.95

Proto Board 203A



Model Number	L x W x H (Inches)	Price
PB-102	7.0 x 4.5 x 1.4	\$25.95
PB-103	9.0 x 6.0 x 1.4	\$44.95
PB-104	9.8 x 8.0 x 1.4	\$54.95

62-Key ASCII Encoder Keyboard Kit



The JE610 62-Key ASCII Encoder Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and -12V @ 10mA for operation.

JE610 \$79.95
62-Key Keyboard only . \$34.95

REGULATED POWER SUPPLY

JE200 5V-1 AMP POWER SUPPLY

- * Uses LM309K
- * Heat sink provided
- * PC Board construction
- * Provides a solid 1 amp @ 5 volts
- * Can supply up to ±5V, ±9V and ±12V with JE205 Adapter
- * Includes components, hardware & instructions
- * Size: 3 1/2" x 5" x 2 1/2"

JE200 \$14.95

JE205 ADAPTER BOARD

- * Adapts to JE200 — ±5V, ±9V and ±12V
- * DC/DC converter w/ +5V input
- * Toroidal hi-speed switching XMF
- * Short circ. protection
- * PC Brd. construction
- * Piggy-back to JE200 board
- * Size: 3 1/2" x 2" x 9/16" h

JE205 \$12.95

\$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus \$1 Insurance (if desired)

Spec Sheets — 25¢
1979 Catalog Available — Send 41¢ stamp



MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
ADVERTISED PRICES GOOD THRU OCTOBER

FREE 1979A CATALOG

PHONE ORDERS WELCOME (415) 592-8097

The Incredible "Pennywhistle 103"



\$139.95 Kit Only

The Pennywhistle 103 is capable of recording data and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with any modern and terminal for telephone "banning" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

- Data Transmission Method Frequency-Shift Keying, full-duplex (half-duplex selectable)
- Maximum Data Rate 300 Baud
- Data Format Asynchronous Serial (return to mark level required between each character)
- Receive Channel Frequencies 2025 Hz for space, 2225 Hz for mark
- Transmit Channel Frequencies Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 925 space, 2225 mark
- Receive Sensitivity -45 dbm acoustically coupled, -15 dbm nominal; Adjustable from -8 dbm to -20 dbm
- Digital Data Interface EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
- Power Requirements 120 VAC, single phase, 10 Watts
- Physical All components mount on a single 5" by 9" printed circuit board. All components included

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

TRS-80

16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:

- * 8 each UPD416-1 (16K Dynamic Rams) 250NS
- * Documentation for conversion

TRS-16K \$75.00

COMPUTER CASSETTES

- * 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- * PLASTIC CASE INCLUDED
- * 12 CASSETTE CAPACITY
- * ADDITIONAL CASSETTES AVAILABLE #C-15-\$2.95 ea

CAS-6 \$14.95

(Case and 6 Cassettes)

SUP'R MOD II

UHF Channel 33 TV Interface Unit Kit

- * Wide Band B/W or Color System
- * Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazler, SOL-20, IRS-80, Challenger, etc.
- * MOD II is pretuned to Channel 33 (UHF).
- * Includes coaxial cable and antenna transformer.

MOD II \$29.95 Kit

Function Generator Kit

- * Provides 3 basic waveforms: sine, triangle & square wave
- * Frequency range from 1 Hz to 100K Hz
- * Output amplitude from 0-volts to over 6 volts (peak to peak)
- * Uses a 12V supply or a ±6V split supply
- * Incl. chip, P.C. board, components and instructions.

JE2206B \$19.95

IDEAL FOR TRS 80 CASSETTE CONTROLLER

"Plug/Jack interface to any computer system requiring remote control of cassette functions"

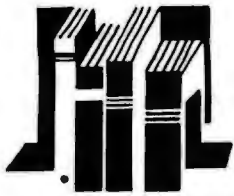
The CC-100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.

#CC-100 **\$29.50**

new Micro-Miniature Joystick

- * 2 each 100K pots (Linear Taper)
- * Printed Circuit Board Mount
- * Size: 1" x 1-3/16" x 1-3/16"

Micro-Miniature Joystick **\$4.95**



Electronics Library

DISCRETE/TRANSISTOR CIRCUIT SOURCMASTER

by Kendall W. Sessions

Contained in this new book are some 1500 circuit diagrams for every electronic interest. The circuits use bipolar, field-effect, unijunction, and new r-f power transistors, all arranged according to circuit class. Captions that enable the reader to breadboard and assemble the referenced circuits accompany each diagram. Devices used in the respective circuits are described. The book is fully indexed and cross-referenced to simplify locating a circuit. Published by John Wiley & Sons, Inc., One Wiley Dr., Somerset, NJ 08873. Hard cover. 411 pages. \$24.95.

HOME RECORDING FOR MUSICIANS

by Craig Anderton

Craig Anderton, one of the country's better-known writers on electronics for musicians,

has written a thorough, basic book for the new breed of serious home recordist. The text covers elementary and advanced aspects of recording basics, studio design and equipment, plain and fancy recording techniques, mixing and editing and maintenance. There are also plans for several build-it-yourself items of equipment, a series of useful appendices, and even a bound-in record illustrating some of the techniques described in the text. Published by Guitar Player Books, P.O. Box 615, Saratoga, CA 95070. 182 pages. \$9.95, soft cover.

PROGRAMMING PROGRAMMABLE CALCULATORS

by Harold S. Engelsohn

One of the more important accomplishments of this manual is the translation of jargon found in most manuals that accompany programmable calculators. Most instructions generally found in programmable calculators are illustrated in full sample programs. Coverage is for the most popular programmables: SR52, SR56, TI57, TI58, and TI59 from Texas Instruments; PR100 from Commodore; and APF's programmable. The manual describes the procedure to use for computing answers to sample problems and explains how to translate these procedures into actual programs. Published by Hayden Book Co., Inc., 50 Essex St., Rochelle Park, NJ 07662. 211 pages. Soft cover. \$9.95.

ABOUT YOUR SUBSCRIPTION

Your subscription to POPULAR ELECTRONICS is maintained on one of the world's most modern, efficient computer systems, and if you're like 99% of our subscribers, you'll never have any reason to complain about your subscription service.

We have found that when complaints do arise, the majority of them occur because people have written their names or addresses differently at different times. For example, if your subscription were listed under "William Jones, Cedar Lane, Middletown, Arizona," and you were to renew it as "Bill Jones, Cedar Lane, Middletown, Arizona," our computer would think that two separate subscriptions were involved, and it would start sending you two copies of POPULAR ELECTRONICS each month. Other examples of combinations of names that would confuse the computer would include: John Henry Smith and Henry Smith; and Mrs. Joseph Jones and Mary Jones. Minor differences in addresses can also lead to difficulties. For example, to the computer, 100 Second St. is not the same as 100 2nd St.

So, please, when you write us about your subscription, be sure to enclose the mailing label from the cover of the magazine—or else copy your name and address exactly as they appear on the mailing label. This will greatly reduce any chance of error, and we will be able to service your request much more quickly.

TRANSFORMERS				
Input 115V 60 Hz	Output	Sh. Wt.	Order No.	Price
5	8H2045 2-18CT	2	48C5	\$4.86
5	9H0290 48CT	5		
10	9G0307 6.3	5	\$4.88	
8	9H0310 2-15CT	6	\$7.88	
15	9H0291 40CT	15		
5	9G0010 14	4	\$8.88	
	or 12	4	\$2.88	
20	9G0069 24	12		
	15	5		
	6	20		
	24	1	\$7.88	
12	8G20326 24	5.5		
	18	1	\$7.88	

SUPER HOT SUPPLIES

3M - SCOTCH FLEX FLAT CABLE
25 Connector - 26 AWG Solid Round Conductor Flat Cable 3M No. 3349/25 available in lengths of 10', 25', 50' @ less than 1/2 price more computer surplus.
Sh. Wt. 2 Lb. 10" 9CS0377 \$5.00
Qty. Ltd. 25' 9CS0378 \$12.50
50' 9CS0379 \$20.00

CARD READER - PDI
(MANUAL 120+ pgs.)
Like NEW surplus units! These 3055H series Peripheral Dynamics Inc. readers read standard IBM cards - Hollerith type. (Reads standard 80 column cards at a maximum rate of 300 cards per minute.) Designed for table top use. 5V logic interface used. Input & output capacity of 500 cards, but on-the-fly loading & unloading is permissible as long as there are approximately 100 in Input Hooper. Operates on 120V 60 Hz. Supplies with Key Data Sheets. Copy of complete operation & maintenance manual (120 pgs.) available for \$35.00 extra. Qty Ltd. List Pr: \$1689.
Sh. Wt. 40 Lbs. D9220365 \$149.88
4 for \$569.88 D9220365 \$569.88
Operations & Maintenance Manual
9220366 \$35.00
4 for \$129.00 9220366 \$129.00
PIEZO BEEP BUZZER - 7/8" Dia.

Unique surplus 7/8" dia. piezo ceramic disk on circuit board gives a DISTINCT high freq. buzz. Unit contains an IC, 2 caps, 6 resistors. The piezo disk is part of a 1-5/8" dia. brass ring spaced 0.2" above a 1/2"x1 1/2" PC board. Entire assembly resonates when 9 to 15V DC is applied to red & black wires and a switch or jumper wire between 2 screw holes. Assembly sold for \$4.89 ea. Yours for only \$1.88. Just add your own horn or resonator to get a FULL sound. Use it as a learning tool or whatever.
Sh. Wt. 7 oz. 9F00217 \$1.88 ea.
6 for \$10 9F00217 \$10.00/6

B&F ENTERPRISES
Dept. P-10
119 Foster Street
Peabody, MA 01960
Phone orders (617) 531-5774—Use your Charge Card - Visa, MC, AE
TERMS: Add Postage; No. C.O.D.'s
\$10.00 Minimum Order

B&F

For
faster
service

USE
ZIP
CODE

on
all
mail

BEAT HIGH GAS PRICES!



CALL FREE
800-257-7955



ELECTRIFY YOUR BIKE!

PEDALPOWER exciting new bike drive tames tough hills. Be independent. Shop when you want. Fits all Bikes, Adult Trikes. Installs in minutes. Thousands sold. Recharges overnight. Travels 100 miles for a dime. **MONEY BACK GUARANTEE.**

Call toll free: 800-257-7955*
Or send today for

**FREE ILLUSTRATED
PEDALPOWER BOOKLET**
Plus free information on complete line of Electric Cars, Electric Bikes and Trikes.

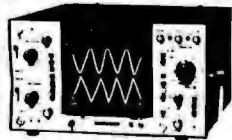
General Engines Co.
5486 Mantua Blvd.
Sewell, N.J. 08080

*In N.J., Alaska, or HI. Call Collect: (609) 468-0270
DEALER INQUIRIES INVITED

CIRCLE NO. 24 ON FREE INFORMATION CARD

LEADER Test Instruments

OSCILLOSCOPES

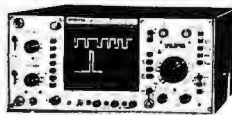


The 30 MHz Dual Trace Oscilloscope with Delay

- 5mV sensitivity.
- Built-in delay line.
- Single shot trigger (CH-1, CH-2).
- 5" P-D-A CRT assures brighter, sharper trace.
- 20 nSec/cm sweep capability plus 11.7 nSec rise time.

MODEL LBO-520

LIST PRICE: \$1120 OUR PRICE: \$935



25 MHz Dual Trace, Oscilloscope Delayed Sweep

- Sweep delay, continuously variable from 1 uSec to 5 Sec.
- 5 mV/Div. Vertical Sensitivity with $\pm 3\%$ acc.
- Rectangular CRT with internal graticule.
- 14 nSec rise time.
- CH-1 or 2 trigger; HF filter; and TV sync.

MODEL LBO-515

LIST PRICE: \$1530 OUR PRICE: \$1350

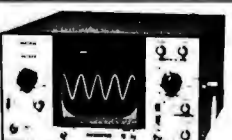


The 20 MHz Dual Trace Oscilloscope

- Add & subtract modes (with CH-2 invert).
- Front panel X-Y operation.
- 17.5 nanosecond rise time.
- Automatic trigger from either channel, including TV sync.
- 10 mV sensitivity.

MODEL LBO-506

LIST PRICE: \$835 OUR PRICE: \$708



The 20 MHz Single Trace Triggered Oscilloscope

- Outstanding trigger sensitivity over entire operational range.
- 10 mV sensitivity and 17.4 nSec rise time.
- X5 magnification ($\pm 5\%$) delivers 100 nSec maximum speed for easy, precise readings.

MODEL LBO-507

LIST PRICE: \$549 OUR PRICE: \$470



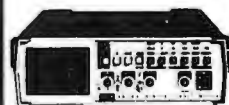
DIGITAL MULTIMETERS NEW



8022A
8020A

- 10,000 M Ω resistance meas with conductance function
- Extensive overload and transient protection
- Rugged construction — MIL-T-28800
- Hi/Lo power ohms for in-circuit resistance and diode testing
- 10 M Ω input impedance doesn't load circuit
- 200 hour battery life — low battery indicator
- Large LCD readout — 2000 counts
- 1 year calibration cycle — only 3 adjustments
- One-hand operation

OUR PRICE: \$129



8010A

OUR PRICE \$239

8012A

OUR PRICE \$299

- Large 3 1/2-Digit LCD's - view in any light
- Conductance function - resistance to 10,000 M Ω
- AC measurements to 50 kHz and higher
- True RMS for ac accuracy
- Touch-Hold probe for tricky places (option)
- Diode test and low power ohms
- One year accuracy reduces calibration costs
- COMMON floatable to 500V
- Recessed jacks reduce shock hazard
- Current mode fuse protection to 600V
- Voltage mode transient protection to 6 kV
- Autozero and autopolarity
- AC or dc current to 10 amps with 8010A
- Resistance resolution to 0.001 Ω with 8012A
- Built-in batteries and charger (Option -01)
- Rugged enough for field or bench

SEND FOR OUR CATALOG

Call TOLL FREE:

NE REGION

N.J. CALL:

(800)526-2514 • (201)227-7720

AMPOWER INST., INC.

26 JUST ROAD, FAIRFIELD, N. J. 07006

OUT OF NE CALL COLLECT
"WE SERVICE WHAT WE SELL"



Mastercharge
BankAmericard
and
COD Accepted
add \$10.00 to
cover shipping
handling insurance
N.J. res. add
5% tax.

FREE
TEST LEADS
WITH EVERY
ORDER

CALL
TODAY PRICES SUBJECT
TO CHANGE

CIRCLE NO. 7 ON FREE INFORMATION CARD



PET 2001 PERSONAL COMPUTER

Quite portable, very affordable and unbelievably versatile, the PET computer may very well be a lifetime investment....

\$595

- 2001 4K bytes memory \$1295.00
- PET 2001-8 Computer Standard PET with integral cassette and calculator type keyboard, 8K bytes of memory . . . \$795.00
- PET 2001-16N Computer 16K bytes, large keyboard w/separate numeric pad and graphics \$995.00
- CBM 2001-16B Computer As above but has standard typewriter. No graphic keys \$995.00
- PET 2001-32N Computer identical to 2001-16N with 32K bytes of memory \$1295.00
- CBM 2001-32B Computer identical to 2001-16B with 32K bytes of memory \$1295.00
- CBM 2022 Printer 80 column dot matrix printer with plain paper or forms handling tractor feed. Full graphics . . . \$995.00
- CBM 2023 Printer 80 column dot matrix printer. Plain paper printer with full graphics \$995.00
- CBM 2040 Dual Floppy Drive intelligent mini floppy system 341K net user storage capacity \$1295.00
- External Cassette Cassette player/recorder to use with PET 2001/8/16/32 \$350.00
- Cable Use this cable to connect your floppy or printer to any CBM Computer \$39.95
- Cable Use this cable when connecting more than one peripheral to any CBM Computer \$49.95
- 160 pages covering all facets of user operation, programming and I/O for PET computers \$9.95
- User Manual

Model	Vdc	Amps	Model	Vdc	Amps
APS 5-3	5	3.0	APS 5-6	5	8.0
APS 12-1.8	12	1.8	APS 12-4	12	5.0
APS 15-1.5	15	1.5	APS 15-3	15	3.0
APS 24-1.2	24	1.0	APS 24-2.2	24	2.2

1-9 10 up 25 up
\$35.50 \$34.00 \$31.75

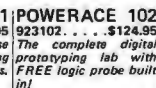
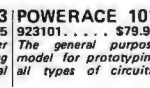
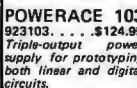
The all-new line of

ACE All-Circuit

Evaluators

WITH POWER

OCTOBER SPECIAL
1802LE
\$9.90



POWERACE 103 923103 . . . \$124.95
Triple-output power supply for prototyping with both linear and digital circuits.

POWERACE 101 923101 . . . \$79.95
The general purpose model for prototyping all types of circuits.

POWERACE 102 923102 . . . \$124.95
The complete digital prototyping lab with FREE logic probe built in!

Intersil LED or LCD 3 1/2 DIGIT PANEL METER KITS
BUILD A WORKING OPM IN 1/2 HOUR WITH THESE COMPLETE EVALUATION KITS

Test these new kits for yourself with Intersil's low cost prototyping kits. Complete with X-Y converter and LCD display (for the 1108) or LED display (for the 1107). Kits provide all materials, including PC board, for a functioning meter.

ICL7106V(LED) \$29.95 ICL7107(LED) \$24.95

5% CARBON FILM RESISTORS

All values from 10 Ω to 10M Ω - Only in multiples of 100 pieces per value

HYBRID AUDIO POWER AMPLIFIERS



P/N	SI-1010Q(10W)	SI-1020Q(20W)	SI-1030Q(30W)	SI-1050Q(50W)	SI-1010Q(Socket for above)
	\$ 6.95	\$13.95	\$19.00	\$27.80	
			TR30 \$12.90	TR50 \$17.90	

* Note: One Transformer can power two audio amplifiers.



HICKOK LX303 DIGITAL MULTIMETER
Compact. Accurate. Dependable. With easy-to-read 3 1/2 liquid crystal display for convenient use in any kind of light. Weighs only 8 ounces. Operates up to 200 hrs on a single 9 volt battery. Nineteen ranges including 200mV to 1000VDC, 100 to 10 Megohms, 100 and 1000 VAC ranges, 10uA and 10mA range. Excellent overload protection, color coordinated case and color coded panel.



SYM-1 NEW LOW PRICE
Fully Assembled & Tested
\$179.00
Including Documentation

KTM-2 CRT/TV Kybd Term \$349

KIM-1 MICROCOMPUTER



FUNCTION GENERATOR KIT XR2206KB
OPERATES ON EITHER
• SINGLE 12V SUPPLY
• 18V SUPPLY
INCLUDES ALL PARTS TO BE MOUNTED ON PC BOARD.
\$19.95
POWER SUPPLY NOT INCLUDED



NEW 30 MEGAHERTZ
PORTABLE, DUAL TRACE MINI-SCOPE
30 MEGAHERTZ
MS-230 Dual Trace \$559.00
15 MEGAHERTZ
MS-215 Dual Trace \$435.00
MS-15 Single Trace \$318.00
with rechargeable batteries and charger

Model	MS-230	MS-215	MS-15
	3.5 lbs (2.0" Hx4.4" Wx5.8" D)	3.5 lbs (2.0" Hx4.4" Wx5.8" D)	3.5 lbs (2.0" Hx4.4" Wx5.8" D)
	41-140	41-141	41-140
	Leather Case (MS-15/215)	10 to 1 Probe (10 Megohm Input)	Leather Case (MS-230)
	\$24.50	\$24.50	\$46.00

OPTIONS
41-140 Leather Case (MS-15/215) \$46.00
41-141 10 to 1 Probe (10 Megohm Input) \$24.50
41-140 Leather Case (MS-230) \$46.00

E-Z-HOOK

AVAILABLE IN 10 RETNA COLORS: Red, black, blue, green, orange, yellow, white, violet, brown or gray. The most unique field-serviceable test connectors available. Fast, safe, sure and trouble free. Please specify Part Number, Jumper Length (when applicable), Color and Price when ordering.

MICRO HOOK

Part No.	Length	Price
204XM-12W	12"	\$1.85
204XM-24W	24"	\$1.85

MINI HOOK

Part No.	Length	Price
204-12W	12"	\$1.70
204-24W	24"	\$1.70

XM Micro Hook to XM Micro Hook

Part No.	Length	Price
201XM	32"	\$1.70

X100W Mini Hook to X100W Mini Hook

Part No.	Length	Price
201W	32"	\$1.65

XM Micro Hook to Banana Plug

Part No.	Length	Price
201XL	32"	\$2.25

X100W Mini Hook to Stacking Banana Plug

Part No.	Length	Price
201XL-1	32"	\$2.25

EXTRA LONG MINI HOOK

Part No.	Length	Price
XL-1	32"	\$1.45

E-Z-HOOK SETS (includes 1 each red, black, blue, green, orange, yellow, white, brown, violet and gray hooks). At this price, buy more than one set.

Part No.	Price
X100WS SET of 10	\$ 8.50
XL-1S SET of 10	\$14.50
XMS SET of 10	\$ 9.00
201WS SET of 10	\$16.50
201XL-1S SET of 10	\$22.50
201XMS SET of 10	\$17.00
204XMS SET of 10	\$17.00
204XMS-12WS SET of 10	\$18.50
204XMS-24WS SET of 10	\$18.50

ANCORONA Send your check or Money Order to P.O. Box 2208P, Culver City, CA 90230. California residents add 6% sales tax. Minimum Order: \$10.00. Add \$1.00 to cover postage and handling. Master Charge and Visa welcomed. Please include your charge card number, Interbank number and expiration date. PHONE ORDERS (213) 641-4084

TUCSON 4318 E. Broadway Tucson, AZ 85711 (602) 851-2346	CULVER CITY 11088 Jefferson Blvd Culver City, CA 90230 (213) 390-3995	SANTA ANA 1300 E. 61st Ave Santa Ana, CA 92705 (714) 547-8424	PORTLAND 1125 N.E. Elm Ave Portland, OR 97208 (503) 254-8661
CANADA, B.C. 5458 Fraser St Vancouver, B.C. V5W2V4 (604) 224-9707	SUNNYVALE 1054 E. El Camino Real Sunnyvale, CA 94087 (408) 243-4121	ATLANTA 3330 Piedmont Rd., N.E. Atlanta, GA 30305 (404) 281-7100	HOUSTON 2848 Richmond Houston, TX 77068 (713) 529-3489

CIRCLE NO. 9 ON FREE INFORMATION CARD

MICRO WORLD™

BRINGING INFORMATION TECHNOLOGY TO YOUR DOORSTEP

- ✓ Quality Microcomputer Products
- ✓ Good Delivery
- ✓ Prices You Can Afford



(reg. \$1599)

\$1349 Double density HORIZON I KIT

Heath Data Systems Printer ...	\$ 895
IP-125 Printer by Integral Data ..	\$ 749
TI-810 Impact Printer	\$1695
Soroc IQ 120 Video Terminal ..	\$ 795
Hazeltine 1500 Video Terminal ..	\$ 995
Mime Terminal	\$ 742
Novation CAT Modem	\$ 199
Hitachi 9" Monitor	\$ 184

place your order TOLL FREE

1-800-528-1418

MICRO WORLD™

1425 W. 12th Place
Tempe, AZ 85281
602-894-1193



High Technology/Low Prices

Econoram* boards are generally available in 3 forms: unkit (sockets and bypass caps are pre-soldered in place for simple, 1 evening assembly), assembled and tested, or qualified under our high-reliability Certified System Component (CSC) program (200 hour burn-in, immediate replacement in event of failure within 1 year of invoice date), 1 year limited warranty on all products. Chart below gives pricing.

Name	Storage	Buss	Configuration	Notes	Unkit	Asm	CSC
• Econoram IIA	8K X 8	S-100	2-4K blocks	1	\$149	\$179	\$239
• Econoram IV	16K X 8	S-100	1-16K	1	\$269	\$329	\$429
• Econoram VIIA-16	16K X 8	S-100	2-4K, 1-8K	1	\$279	\$339	\$439
• Econoram VIIA-32	24K X 8	S-100	2-4K, 2-8K	1	\$398	\$485	\$605
• Econoram IX-16	16K X 8	Dig Grp	2-4K, 1-8K	1	\$319	\$379	n/a
• Econoram IX-32	32K X 8	Dig Grp	2-4K, 1-8K, 1-16K	1	\$559	\$639	n/a
• Econoram X	32K X 8	S-100	2-8K, 1-16K	1	\$529	\$649	\$789
• Econoram XI	32K X 8	SBC/BLC	2-8K, 1-16K	1	n/a	n/a	\$1050
• Econoram XII-16	16K X 8	S-100	see notes	1, 2	\$329	\$419	\$519
• Econoram XII-24	24K X 8	S-100	see notes	1, 2	\$429	\$539	\$649
• Econoram XIII	32K X 8	S-100	see notes	1, 3	\$559	\$699	\$849
• Econoram XIV	16K X 8	S-100	see notes	1, 4, 5	\$289	\$349	\$449
• Econoram XV-16	16K X 8	H8	1-16K	1, 6	\$329	\$395	n/a
• Econoram XV-32	32K X 8	H8	2-16K	1, 6	\$599	\$729	n/a

Notes:

1. Works at 5 MHz with 8085, 4 MHz with Z-80.
2. Bank select board — 2 independent banks addressable on 8K boundaries.
3. Bank select board — 2 independent banks addressable on 16K boundaries.
4. Bank select board — 1 bank addressable on 4K boundaries.
5. 24 address lines for extended addressing.
6. Bank select option included for implementing memory systems greater than 64K.

*Econoram is a trade mark of Bill Godbout Electronics.

ECONORAM II CLOSEOUT

\$129 unkit (3/\$375), \$155 asm

Limited quantity. Our new Econoram IIA is out, but this is still a great memory for 2 MHz systems. Low power, configured as 2 independent 4K blocks, reliable and cost-effective operation. 1 evening assembly, 1 year limited warranty.

16K MEMORY EXPANSION CHIP SET ★\$87.20★

20% off our regular \$109 price while they last. For Radio Shack-80, Apple, Exidy Sorcerer memory expansion. Low power, 250 ns parts. DIP shunts and instructions included. 1 year limited warranty.

INTERFACER S-100 I/O BOARD \$189 unkit, \$249 asm

Dual serial port with 2 full duplex parallel ports for RS-232 handshake; crystal controlled timebase; operates with 2 to 5 MHz systems; many software programmable functions; much more.

2708 S-100 EROM

BOARD \$85 unkit

4 independently addressable 4K blocks. Includes all support chips and manual, but does not include EROMs.

TERMS: Cal. res. add tax. Allow 5% for shipping, excess refunded. VISA/Mastercharge call our 24 hour order desk at (415) 562-0636. COD OK with street address for UPS. Prices good through cover month of magazine.

GODBOUT

GODBOUT ELECTRONICS
Bldg. 725, Oakland Airport, CA 94614

FREE FLYER: We'll be glad to tell you much more than the space of this ad permits. Just send your name and address, we'll take care of the rest. Include 41¢ in stamps for 1st class delivery if desired.

CIRCLE NO. 34 ON FREE INFORMATION CARD

CIRCLE NO. 25 ON FREE INFORMATION CARD

HICKOK 3 1/2 Digit Mini-Multimeter

MODEL LX 303 \$69.50

Sinclair PDM35 digital MultiMeter

\$52.95

BK PRECISION 3 1/2-Digit Portable DMM

Model 2800 \$299.95

NLS 15 MHz Mini Oscilloscope

Model MS 15 \$269.95

ESSE Logic Probe

Model LP-1 \$40.00

30MHz Dual Trace with Delay Line

Model L80-520 \$889.95

Function Generator

Model 2001 \$127.50

GOULD 15 MHz Dual Trace

Model DS255 \$795

Auto Stereo 40 Watt Power Booster

Model POW-40 \$24.95

Weller Xcelite

Model 999P \$15.95

Service Master Attache Style Tool Kit

Model 99SM \$42.95

Miniature High Fidelity Stereo Speaker System

Reg. \$139.00 \$69.50

Magnifier LAMP

Model MG 10A \$49.50

Chess Challenger

Model LCX \$179.95

SENCORE TV-VTR-MATV and Video Analyzer

Model VA48 \$875.00

Logic Monitor

Model LM-1 \$52.95

Remote Control for Lights & Appliances

Model 250 \$299.95

Touch K100 Scanner

Reg. \$269 \$199.95

30MHz Portable Frequency Counter

Model 1827 \$59.95

ESSE CONTINENTAL SPECIALTIES 100 MHz 8-Digit Counter

Model MAX-100 \$119.00

ESSE PS500 500MHZ Prescaler

\$52.95

BK PRECISION Digital Capacitance Meter

Model 820 \$249.95

CODE-A-PHONE Telephone Answering Devices

Model 1400 \$199.95

WAHL NEW ISO-TIP "Quick Charge"

Model 7800 \$27.95

BSR SYSTEM X-1000 Remote Control for Lights & Appliances

Model 250 \$299.95

HICKOK Function Generator

Model 270 \$169.15

Bearcat Scanner

Model 250 \$299.95

Regency 10 channel computer controlled

Model 250 \$199.95

BSR Changer Accessories

Model BSR-129 \$29.95

Microflame Deluxe Gas Torch Kit

Model 4400 \$39.95

In-Dash AM/FM 8 Track Stereo

Model C-777 \$52.50

Weller Controlled Output Soldering Station

Model WTC-PN \$45.00

FREE 1979 Catalog

Call TOLL FREE (800) 645-9518

Weller Controlled Output Soldering Station

Model WTC-PN \$45.00

ESSE 30MHz Dual Trace with Delay Line

Model L80-520 \$889.95

FM/AM Tuner Chassis



499

RA-744

Reg. ~~899~~

- 2 Gang Tuning Capacitor
- Replacement
- 3-Pos. Selector Switch • Hobby
- Wire in to Any Amplifier
- Auxiliary Input
- Requires 8.2 VDC Voltage
- With Schematic
- 6x2 1/2 x 2 1/4" • 1 lb.

Volume Controls



39c

Reg. ~~129~~
VC-274

- 12 Piece Kit • Bargain Hunters Special
- Less Than 11¢ Each • 12 Popular Values
- Various Diameters & Lengths • Wt. 1 lb.

Cassettes

60 Minute



\$1

TA-879

Reg. ~~129~~

- 180 Minutes of Recording Time
- Less Than 1¢ Per Minute
- Music or Voice • Wt. 1/2 lb.

Thomas Air Compressor



1599

XM-771

Reg. ~~2999~~

- Use for Paint Sprayer, Air Brush, Tires, Air Bag Pump
- 117 VAC @ 1.2 Amps.
- Diaphragm Type
- Capacitor Start Motor
- Requires AC Cord
- 5 CFM at Max
- Die-Cast
- 4 1/2" dia. x 8 1/2" long
- Inlet/Outlet—Std. 1/4"
- Washable Filter • 15 lb.

AC to 3, 4.5, 6, 9 VDC Adapter



399

BA-159 Reg. ~~799~~

- For Recorders, Radios, Calculators
- Converts Battery Devices to House Current • Styles Vary • 2 1/2 x 1 1/2 x 1 1/2" • Wt. 1 lb.

8-Track Tapes

40 Minutes



69c

TA-807 Reg. ~~99c~~

- Quality Reproduction
- Length For Recording Some LP's, etc.
- Erased—Not Used • Shpg. wt. 1/2 lb.

Mono FM/AM Receiver Chassis



449

RA-573

Reg. ~~899~~

- Phono Inputs
- AM-FM Antennas
- Extension Speaker Outputs
- Tape Outputs
- Size: 9 x 4 x 3"
- 11-12 VAC Operation
- Schematic
- Limited Quantities
- Shpg. wt. 2 lbs.

Pillow Speaker



129

SS-995 Reg. ~~129~~

- Compact Size • 6-Ft. of Cable
- For Late Night Listening
- 3.5mm Plug • Shpg. wt. 1/2 lb.

12 VDC Fan



199

MO-452

- Cool Mobile Electronic Gear
- 120V Heating Element • Fan 1 1/2 x 2 1/2"
- 12 VDC Fan and Motor • Wt. 1/2 lb.

1¢ SALE BUY 1 AT REGULAR PRICE GET 2nd ONE OF SAME NUMBER FOR ONLY **1¢**



Back-of-Set VHF Antenna

499 each 2/470

AA-875

- Works completely hidden from view. 4-section dipoles can turn to any position. With lead-in wire, terminals and mounting bracket. Wt. 2 lbs.

Cassette Head Cleaner



2/301

TA-545

- Extends Tape Life
- Shpg. wt. 1/4 lb.

5-Digit Counter



2/301

XM-543

- 3/16 x 1/4" Diameter Shaft
- Size: 1 1/2 x 1 1/4 x 1 1/4"
- Shpg. wt. 1/2 lb.

5 1/4" Round Speaker Grilles



2/80c

CA-888

- 79c Pair
- Pkg. of 2
- Shpg. wt. 1/4 lb.

5-Piece Solenoid Kit



2/250

SW-883

- Styles May Vary
- Shpg. wt. 5 lbs.

12 VDC Battery Charger



2/996

AU-652

- For Trickle Charging Overnight or Idle Periods
- Shpg. wt. 2 lbs.

Gutter Mount



2/\$2

AA-218

- Use With Most All Antennas
- Size: 2 1/4 x 1 1/4 x 2"
- Shpg. wt. 1 lb.

FM Dipole Antenna



2/130

AA-211

- Attaches to Stereo or Radio
- Shpg. wt. 1/2 lb.

Electret Condenser Mike Element



2/501

MK-128

- Miniature Size Only 3/8" Thick
- Shpg. wt. 1 lb.

9 VDC Horn



2/199

XM-808

- Adjustable 1 1/4" Diameter
- 3/4" Deep • Wt. 1/4 lb.

12 VDC Relay



2/150

SW-854

- Single Pole, Single Throw N.O. Contacts • Shpg. wt. 1/4 lb.

Photo Cell



2/101

TR-567

- 1300-4 Meg Ohms
- Shpg. wt. 1/4 lb.

Olson electronics
260 S. FORGE ST. DEPT. IU
AKRON, OHIO 44327
FREE!

NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____

Qty.	Stk. #	Description	Price Ea.	Total

24 Hour PHONE Service Call (216)535-1800

☐ Please send me a free subscription

to Olson Value Packed Catalog. (Within the Continental USA Only)

Postage _____
Tax _____
TOTAL _____

Electronics Classified

REGULAR CLASSIFIED: COMMERCIAL RATE: For firms or individuals offering commercial products or services, \$2.75 per word. Minimum order \$41.25. **EXPAND-AD® CLASSIFIED RATE:** \$4.10 per word. Minimum order \$61.50. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance. **PERSONAL RATE:** For individuals with a personal item to buy or sell, \$1.60 per word. No minimum! **DISPLAY CLASSIFIED:** 1" by 1 column (2-1/4" wide), \$330. 2" by 1 column, \$660.00. 3" by 1 column, \$990.00. Advertiser to supply film positives. For frequency rates, please inquire. **GENERAL INFORMATION:** Ad copy must be typewritten or clearly printed. Payment must accompany copy except when ads are to be billed on credit cards — American Express, Diners Club, Master Charge, VISA (supply expiration date) — or when ads are placed by accredited advertising agencies. First word in all ads set in caps. All copy subject to publisher's approval. All advertisers using Post Office Boxes in their addresses **MUST** supply publisher with permanent address and telephone number before ad can be run. Advertisements will not be published which advertise or promote the use of devices for the surreptitious interception of communications. Ads are not acknowledged. They will appear in first issue to go to press after closing date. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to Classified Advertising, **POPULAR ELECTRONICS**, One Park Avenue, New York, N.Y. 10016. For inquiries, contact Linda Lemberg at (212) 725-3924.

FOR SALE

FREE! Bargain Catalog—I.C.'s, LED's, readouts, fiber optics, calculators parts & kits, semiconductors, parts. Poly Paks, Box 942PE, Lynnfield, Mass. 01940.

GOVERNMENT and industrial surplus receivers, transmitters, sniperscopes, electronic parts, Picture Catalog 25 cents. Meshna, Nahant, Mass. 01908.

LOWEST Prices Electronic Parts. Confidential Catalog Free. KNAPP, 4750 96th St N., St. Petersburg, FL 33708.

ELECTRONIC PARTS, semiconductors, kits. FREE FLYER. Large catalog \$1.00 deposit. BIGELOW ELECTRONICS, Bluffton, OK 45817.

RADIO—T.V. Tubes—36 cents each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

AMATEUR SCIENTISTS, Electronics Experimenters, Science Fair Students . . . Construction plans — Complete, including drawings, schematics, parts list with prices and sources . . . Robot Man — Psychedelic shows — Lasers — Emotion/Lie Detector — Touch Tone Dial — Quadraphonic Adapter — Transistorized Ignition — Burglar Alarm — Sound Meter . . . over 60 items. Send \$1.00 (no stamps) for complete catalog. Technical Writers Group, Box 5994, University Station, Raleigh, N.C. 27650.

SOUND SYNTHESIZER KITS—Surf \$14.95, Wind \$14.95, Wind Chimes \$19.95, Musical Accessories, many more. Catalog free. PAIA Electronics, Box J14359, Oklahoma City, OK 73114.

HEAR POLICE / FIRE Dispatchers! Catalog shows exclusive directories of "confidential" channels, scanners. Send postage stamp. Communications, Box 56-PE, Commack, N.Y. 11725.

TELETYPE EQUIPMENT: Copy Military, Press, Weather, Amateur, Commercial Transmissions. Catalog \$1.00. **WEATHER MAP RECORDERS:** Copy Satellite Photographs, National-Local Weather Maps. Learn How! \$1.00. Atlantic Sales, 3730 Nautilus Ave., Brooklyn, NY 11224. Phone: (212) 372-0349.

WHOLESALE C.B., Scanners, Antennas, Catalog 25 cents. Crystals: Special cut, \$4.95, Monitor \$3.95, Sand make, model, frequency. G. Enterprises, Box 461P, Clearfield, UT 84015.

BUILD AND SAVE TELEPHONES, TELEVISION, DETECTIVE, BROADCAST Electronics. We sell construction plans with an Engineering Service. Speakerphones, Answering Machines, Carphones, Phonevision, Dialers, Color TV Converters, VTR, Games, \$25 TV Camera, Electron Microscope, Special Effects Generator, Time Base Corrector, Chroma Key. Engineering Courses in Telephone, Integrated Circuits, Detective Electronics. **PLUS MUCH MORE.** NEW Super Hobby Catalog PLUS year's subscription to Electronic News Letter, \$1.00. Don Britton Enterprises, 6200 Wilshire Blvd., Los Angeles, Calif. 90046.

NAME BRAND Test Equipment. Up to 50% discount. Free catalog. Salen Electronics, Box 82, Skokie, Illinois 60077.

NAME BRAND TEST EQUIPMENT at discount prices. 72 page catalogue free. Write: Dept. PE, North American Electronics, 1468 West 25th Street, Cleveland, OH 44113.

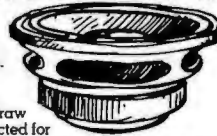
UNSCRAMBLERS for any scanner. Several models available. Free literature. Capri Electronics, 8753T Windom, St. Louis, MO 63114.

UNSCRAMBLER KIT. Tunes all scramble frequencies, may be built-in most scanners, 2-3/4 x 2-1/4 x 1/2. \$19.95. Factory built Code-Breaker. \$29.95. Free Catalog: KRYSTAL KITS, Box 445, Bentonville, Ark. 72712. (501) 273-5340.

BUILD THE ARTISAN ELECTRIC ORGAN . . . The 20th century successor to the classic pipe organ. Kits feature modular construction, with logic controlled stops and RAM Pre-Set Memory System. Be an art-isan. Write for our free brochure. AOK Manufacturing, Inc., Box 445, Kenmore, WA 98028.

SpeakerGuts.

The absolute latest in advanced speaker technology. *Wave Aperture™ Drivers, the Patented Nestroic Woofer System™*, raw speaker components selected for their excellence. Horns, crossovers, subwoofers, woofers, midranges, horn and dome tweeters. Over 30 in all. Build your own speaker system and we'll provide top quality speakers and design information. Send for FREE 48 page color catalog from the largest, most experienced speaker kit manufacturer in the world. **DONT DELAY. Write today!**



Dept. APE, 735 N. Northlake Way
Seattle, Washington 98103

POLICE/FIRE SCANNERS, crystals, antennas, CBs, Radar Detectors. HPR, Box 19224, Denver, CO 80219.

CB RADIOS, VHF-UHF Scanners, Crystal, Antennas, Radar Detectors. Wholesale. Southland, Box 3591, Baytown, TX 77520.

UNSCRAMBLE CODED MESSAGES from Police, Fire and Medical Channels. Same day service. Satisfaction guaranteed. Don Nobles Electronics, Inc., Rt. 7, Box 265B, Hot Springs, Arkansas 71901. (501) 623-6027.

PRINTED CIRCUIT supplies, chemicals, tools, artwork, plating solutions. Major credit cards. Catalog \$1.00, refundable. CIRCLEX, Box 198, Marcy, NY 13403.

RECONDITIONED TEST EQUIPMENT \$1.00 for catalog. WALTER'S TEST EQUIPMENT, 2697 Nickel, San Pablo, CA 94806, (415) 758-1050.

NEGATIVE ION GENERATORS AND ACCESSORIES. (Kits). Fascinating details—\$1.00. Golden Enterprises, Box 1282-PE, Glendale, Arizona 85311.

Super Powerful Wireless Mic
10 times more powerful than other mics.
Transmits up to 1/4 mile to any FM radio.
Easy to assemble kit. 15V battery (not incl.)
Call (305) 725-1000 or send \$18.95 + \$1.00 shipping to USI Corp., P.O. Box PE-2052, Melbourne, FL 32901. COD's accept. For catalog of transmitters, voice scramblers and other specialty items, enclose \$2.00 to USI Corp.


\$18.95
 Qty. Disc Avail

TRANSISTORS, IC's, RF-Power, for communications, TV, audio repairs, 2SC756A - \$2.00, 2SC1307 - \$2.15, 2N6084 - \$14.50, STK439 - \$8.75. Many more. Free catalog. B&D Enterprises, Box 32, Mt. Jewett, PA 16740. (814) 837-8820.

PRINTED CIRCUIT BOARDS, your artwork, 45¢ sq. in. single sided, 60¢ sq. in. double sided. Mail your order now, or send for free details. Digitronics, P.O. Box 2494, Toledo, OH 43606.

ELECTRONIC TEST EQUIPMENT. Free catalog. E. French, PO Box 249, Aurora, IL 60507.

AUDIO NOISE REDUCTION KIT — 318 SILENCER for tapes, records, FM. Free brochure. LOGICAL SYSTEMS, 3314 'H' St., Vancouver, Washington 98663.

LATEST AND BEST in electronic components, books and supplies. Write for big free catalogue. TRI-TEK, 7808 N 27 Ave., Phoenix, AZ 85021.

BARGAINS GALORE! Monthly swap sheet for radio collectors, hams, experimenters, etc. Send long SASE for sample. Electronics Trader, Box 2377, Argus, CA 93562.

SWL'S: Tune in on the exciting world of Radioteletype and Morse transmissions of international news bulletins, weather, ships, and foreign embassy traffic. Code Translator Video Display unit hooks directly to your shortwave receiver \$495. Video monitor \$199, or use your TV with RF modulator \$30. Instruction manual, drawings \$5. ODS, Box 2346, Gaithersburg, Maryland 20860.

FREE SAMPLE of optical fiber if you send for our catalog of fiber optic and electronic supplies. FIBERTRONICS, Box 322, Primos, PA 19018.

New SATELLITE
For the TV home.




Supersharpest Reception—Color Like Never Before

Get over 50 channels of television directly from the satellite! HBO, Showtime, the Superstations, and sports from around the world!

Works Anywhere!

Buy complete or build and save. Our book tells everything! Send \$7.95 today or call our 24 hr. C.O.D. Hotline!

(305) 869-4283

SPACECOAST RESEARCH
P.O. Box 442, Dept. H, Altamonte Springs, FL 32701

TREMENDOUS BUYS In New And Gov't Surplus Equipment

Dial Telephone "SUPER BUY"

• Save us the labor costs of cleaning and polishing and save \$\$\$\$ on standard dial telephones. Work on any commercial system. Complete. (no parts missing) in good working order. Your choice of desk or wall models. These are take-outs from commercial service (no toys). Instructions furnished.

Wall Model: #715-WPE
Desk Model: #713-PE

\$7.95
PRICE EACH

PREPAID IN U.S.A.
Does not include HAWAII, ALASKA, P.R.



FREE CATALOG shows BIG SAVINGS On:

- ELECTRONICS
- ELECTRICAL
- ALARM SYSTEMS
- TELEPHONES
- PUMPS
- BINOCULARS
- GEAR MOTORS
- WINCHES
- SERVITING INSTRUMENTS
- GENERATORS
- COMPRESSORS
- HYDRAULICS
- POWER TOOLS
- WELDERS
- POWER PLANTS
- CHEMICAL SPRAYING
- TARPOLINS
- MANY OTHERS

Surplus Center Box 82209-PE Lincoln, Ne. 68501

USED AMATEUR RADIO EQUIPMENT FOR SALE. Nationwide list \$2.50. Amateurs Exchange, Box 374-PE, Visalia, CA 93279.

NEW ELECTRONIC PARTS. Continuously stocked. Stamp brings catalog. Daytapro Electronics, 3029 N. Wilshire Ln, Arlington Hts., IL 60004.

STARSHIP/OPTICAL DEVICES will convert your car into a flying disc. Plans \$5.00, Kits \$10.00. Crow Research, 11441 Heather St. NW, Coon Rapids, MN 55433.

NEW! "TOUCH" LIGHT SWITCH. TOUCH PLATE bolts to any cover plate. Available in chrome or brass. Complete - \$28.95, with dimming - \$32.95. M.M. Research, P.O. Box 665, Montgomery, WV 25136.

WIRELESS RECEIVER/TRANSMITTER SET \$40.00, 2 sets \$60.00. Extra transmitters \$12.00. Telephone dialer with receiver built in, 1 pocket transmitter \$50.00, for emergencies. Alarm Services, 17W116 White Pines Rd., Bensenville, IL 60106.

COMMON STOCK Rate of Return Program for T.I. Calculators \$1. Programs, P.O. Box 2232, Lancaster, CA 93534.

PORTABLE OR CLOCK RADIO modified to receive FM sub-carrier music, talk programs. Specify choice, \$38. FM Atlas, Adolt MN 55701.

CREATE your own computer, craft or tech venture. FREE Details. Synergetics, Box 1077-P, Thatcher, AZ 85552.

ELECTRONICS COMPLETED KITS. No wiring. FM mic. VU meter. Touch control switch programmable music block. Wheel fortune game, etc. Save up to 50%. Write for free catalog today. Postcard will do. Supertronics Inc., 39 Bowery, Box 88, New York, NY 10002.

"SECRET" U.S. GOVERNMENT FREQUENCIES. Over 100. FBI, Border Patrol, etc. \$5.00. ARK, Box 27412, Tucson, AZ 85726.

SATELLITE TELEVISION — MOVIES, SPORTS, etc. Build or buy earth station. Send \$3.00 for information. Satellite T.V., Box 140, Oxford, NY 13830.

OSCILLOSCOPES, other test equipment, SASE for list. RG Electronics, 5175 Westland, New Carlisle, OH 45344.

SCANNER CRYSTALS \$2.95. Diamond phono needles \$2.95. Cobra C.B. power mics \$9.95. Add 50¢ for shipping, 1.00 for catalogue (refundable). WAVELENGTH, Box 85, Noblesville, IN 46060.

SUPER BASS SUBWOOFER plans. Computer designed unit outperforms commercial models. Build for under \$90. Parts available. Illustrated cabinet and crossover plans, send \$9.95. Bucella Laboratories, Box 288, Buffalo, NY 14205.

PLANS AND KITS

AMAZING ELECTRONIC PRODUCTS

LASERS SUPER POWERED, RIFLE, PISTOL, POCKET - SEE IN DARK - PYRO-TECHNICAL DE-BUGGING - UNCRAMBLERS - GIANT TESLA - STUNWAND - TV DISRUPTER - ENERGY PRODUCING, SCIENTIFIC DETECTION, ELECTRICITY, CHEMICAL, ULTRASONIC, CB, AERO, AUTO AND MECH DEVICES, HUNDREDS MORE - ALL NEW PLUS INFO UNLTD PARTS SERVICE.

INFORMATION unfilled

CATALOG \$1 Dept. E8, Box 716, Amherst, NH 03031

FREE KIT Catalog contains Test and Experimenter's Equipment. Dage Scientific Instruments, Box 1054P, Livermore, CA 94550.



TIGER 500 SIMPLI-KIT

FOR THE DO-IT-YOURSELF

NOW! a high quality CD ELECTRONIC IGNITION SYSTEM in kit form.

Contains all components and solder to build complete Solid-State Electronic CD Ignition System for your car. Assembly requires less than 3 hours.

- Increases MPG 15%
- Eliminates 4 or 5 tune-ups
- Increases horsepower 15%
- Instant starting, any weather
- Plugs and Points last 50,000 miles
- Dual system switch

Fits only 12 volt neg. ground...
Only \$26.95 postpaid

***Tri-Star Corporation**
P.O. Box 1727 Grand Junction, Colorado 81501

TV-OSCILLOSCOPE CONVERTER externally adapts TV into audio-frequency oscilloscope. Info. \$1.00, Plans \$7.50, with P.C. \$15.00, complete kit \$60.00. Evolutionics, Box 855-L, San Rafael, CA 94902.

PRINTED CIRCUIT Boards from sketch or artwork. Kit projects. Free details. DANOCINTHS Inc., Box 261, Westland, MI 48185.

BUILD YOUR OWN SYMPHONY OF SOUND!



It's fun and easy — takes just minutes a day! Complete kits for organs, pianos, strings, rhythms, amplifiers, synthesizers. Also factory assembled. 104-page catalog \$2.00

WERSI

Wersi Electronics, Inc.
Dept. ZD, 1720 Hempstead Road
Lancaster, PA 17601

ELECTRONICS KITS: For information, send self addressed stamped envelope. GI Kits, Box 2329, Garland, TX 75041.

HIFI STEREO AMPLIFIER. Construct your own, complete pc mounts and instructions. Info \$1.00. Otel, 9626 Golf Terrace, Des Plaines, IL 60016.

FREE SCHEMATIC: Touch-lite electronic switch and dimmer. Energy saver. Touch-lite, Box 161, Plainville, NY 13137.

DIGITAL CAPACITANCE — INDUCTANCE METER for \$20.00. Plans, \$3.95. BHL Electronics, P.O. Box 2804, C.S., Pullman, WA 99163.

UNUSUAL SCIENTIFIC CREATIONS. Catalog \$1.00. Robotics — Ultra-high powered lasers — High voltage equipment — Chemicals — etc.!!! Advanced Research Scientific, P.O. Box 19041, Detroit, MI 48219.

ELECTRONIC KITS including wireless microphones, alarms, clocks, sound effects, etc. Brochure. Electrokit, Box 568, Milford, Mass. 01757.

PROJECTION TV KIT! Ready to assemble. REAL walnut finish. 4.4' screen, projector kit... \$599. Master Charge and VISA accepted. For Catalogue send 50¢ to: VIDEO PROJECTION, P.O. Box 158, Lake Zurich, Ill. 60047.

PROJECTION TV... Convert your TV to project 7 Foot picture. Results equal to \$2,500 projector. Total cost less than \$20.00. PLANS & LENS \$16.00. Illustrated info. FREE: Macromca, Washington Crossing, PA 18977.

GRAPHIC EQUALIZER KIT only \$100. Twelve bands/channel, superior specifications. Send \$2.50 (refundable) for complete instructions with review, or write: Symmetric Sound Systems, Dept. P, 912 Knobcone, Loveland, CO 80537.

DOLBY ADD-ON ENCODES/DECODES, TAPE, FM Kit or assembled. PEO INTEGREGX, Box 747, Havertown, PA. 19083.

SAVE MONEY, ENERGY. Wattage reducer HALVES electrical consumption. Proven. Plans \$3.00. Magi Palmer, Box 6300, Sunny Isles, St. Croix, U.S.V.I. 00820.

TELEPHONES & PARTS

TELEPHONES UNLIMITED, EQUIPMENT SUPPLIES. ALL TYPES, REGULAR, KEYED, MODULAR. FREE CATALOG. Call now toll free. (800) 824-7888. In California (800) 852-7777. Alaska-Hawaii (800) 824-7919. Ask for operator 738.

ALARMS

QUALITY BURGLAR-FIRE ALARM EQUIPMENT at discount prices. Free Catalog! Steffens, Box 624L, Cranford, N.J. 07016.

Burglar-Fire Protection



Protect Your Life, Home, Business, Auto, etc.

- Our catalog shows how. Install your own alarm systems and devices and save \$\$\$\$.
- We offer FREE write-in engineering service.

FREE CATALOG Lowest Prices on Reliable, High-Quality Alarm Systems and Devices

Burdex Security Co. Box 82802-PE Lincoln, Ne. 68501

PROTECT IGNITION, CB, any D-C circuit from unauthorized operation. Plans explain how to wire inexpensive parts to make foolproof alarm. \$2.99. Seqswitch-PE, Box 1084, San Mateo, CA 94403.

ALTERNATE ENERGY



AUTO ALTERNATOR TECHNOLOGY HANDBOOK

NOW YOU CAN Buy Alternators Locally for \$10 or Less! Obtain 220V or 440V or Run 400cyc Surplus Equip Use Auto Regs or Build Simple Adjustable IC Electronic Reg for 0-120V 100A power plants. Also Detailed Data & Steps for Rewinding and Core Modifications easily using simple tools! Theory Plus many Efficiency Increase Hookups Schematics etc to Fully utilize Engine, Water and Wind Energy Systems!! \$ NO Secret! Just \$5.00 PPD 1st Cl *Don't Miss It!*

ESSco's Pubs. Ref. P.E.
BOX 2004, MT. Vernon, N.Y. 10550

HIGH FIDELITY

DIAMOND NEEDLES and Stereo Cartridges at Discount prices for Shure, Pickering, Stanton, Empire, Grado and ADC. Send for free catalog. LYLE CARTRIDGES, Dept. P, Box 69, Kensington Station, Brooklyn, New York 11218. For Fast Service call Toll Free 800-221-0906.

LOWEST PRICES on stereo components. BOSE, SAE, DBX and more. Dynamic Sound, Box 168(B), Starkville, MS 39759. (601) 323-0750. 1 PM - 9 PM.

WANTED

GOLD, Silver, Platinum, Mercury, Tantalum wanted. Highest prices paid by refinery. Ores assayed. Free circular. Mercury Terminal, Norwood, MA 02062.

TUBES

RADIO & T.V. Tubes—36 cents each. Send for free Catalog. Cornell, 4213 University, San Diego, Calif. 92105.

TUBES: "Oldies", Latest. Supplies, components, schematics. Catalog Free (stamp appreciated). Steinmetz, 7519-PE Maplewood, Hammond, Ind. 46324.

TUBES-RECEIVING, Industrial and Semiconductors Factory Boxed. Free price sheet including TV, Radio and audio parts list. Translateronic, Inc., 1365 39th St., Brooklyn, New York 11218. Telephone: (212) 633-2800. Toll free: 800-221-5802.

RADIO AND TV TUBES 1938 to 1978 \$1.00 ea. PRELLER TV, Augusta, AR 72006. (501) 347-2281.

ANTIQUE TUBES. Ediswan Valve, 26, NY224, etc. S.A.S.E. for list. Fuller, 18 Locust Ct., Sicklerville, NJ 08081.

GOVERNMENT SURPLUS

MANUALS for Govt Surplus radios, test sets, scopes. List 50 cents (coin). Books, 7218 Roanne Drive, Washington, D.C. 20021.

JEEPS—\$59.30!! — CARS—\$33.50!! — 450,000 ITEMS!! — GOVERNMENT SURPLUS!! — Most COMPREHENSIVE DIRECTORY AVAILABLE (tells how, where to buy!!) — YOUR AREA!! — \$2.00!! — MONEYBACK GUARANTEE!! — "Government Information Services", Department GE-100, Box 99249, San Francisco, California 94109.

GOVERNMENT SURPLUS. Buy your Area. How, where. Send \$2.00. SURPLUS HEADQUARTERS BUILDING, Box 30177-PE, Washington, D.C. 20014.

"GOVERNMENT SURPLUS DIRECTORY" Buy 500,000 items (including Jeeps)... low as 2¢ on dollar! Most complete information available — \$2.00 (guaranteed). Surplus Disposal, Box 19107-HJ, Washington, DC 20038.

JEEPS... \$33.30!!... 525,000 Items! Buy in your area! How! Where! "Guaranteed 1979 Government Surplus Directory" — Including: "Buy Government LANDS Guide," — "Government Oil-Gas LOTTERY Guide" — \$2.00. Gsurplus, Box 2009, Syracuse, New York 13220.

INSTRUCTION

UNIVERSITY DEGREES BY MAIL! Bachelors, Masters, Ph.D's. Free revealing details. Counseling, Box 317-PE10, Tustin, California 92680.

RADIO BROADCASTING: Become DJ, engineer. Start your own station — investment/experience unnecessary! Receive free equipment, records. Free details. Broadcasting, Box 130-A10, Paradise, CA 95969.

LEARN WHILE ASLEEP! HYPNOTIZE! Astonishing details, strange catalog free! Autosuggestion, Box 24-ZD, Olympia, Washington 98507.

INTENSIVE 5 week course for Broadcast Engineers. FCC First Class license. Student rooms at the school. Radio Engineering Inc., 61 N. Pineapple Ave., Sarasota, FL 33577.

1979 "TESTS - ANSWERS" for FCC First Class License. Plus - "Self Study Ability Test." Proven! \$9.95 Unconditional Moneyback Guarantee. Command Productions, Box 26348-P, San Francisco, CA 94126.

LEARN ELECTRONIC ORGAN SERVICING at home. Completely revised course covers latest models including digital, LSI's, synthesizers, etc. NILES BRYANT SCHOOL, PO Box 20153, Sacramento, CA 95820.

COLLEGE DEGREES BY MAIL! No classes. Fast, Economical, Accredited. FREE Revealing details. Success, Box 12500-R10, Columbus, Ohio 43212.

BEGINNERS!! Learn to design and trouble shoot electronic circuits. Send \$7.95 to Chapel Company, Department PE-10, 3724 Colonial Ave., Erie, PA 16506.

PERSONALS

MAKE FRIENDS WORLDWIDE through international correspondence, illustrated brochure free. Hermes-Verlag, Box 110660/Z, D-1000 Berlin 11, W. Germany.

MAILORDER SUCCESS!! Interested? Free expose. TWP-V, Box 6226, Toledo, Ohio 43614.

FOR INVENTORS

PATENT AND DEVELOP Your invention. Registered Patent Agent and Licensed Professional Engineer, Send for FREE PATENT INFORMATION every inventor should have. Richard L. Miller, P.E., 3612 Woolworth Building, New York, NY 10007. (212) 267-5252.

INVENTIONS WANTED

FREE CONSULTATION • NO IDEA TOO SMALL
Disclosure protection Cash or royalties from manufacturers seeking new ideas. For free information on how to protect your ideas, Call or Write

American Inventors Corp.

59 Interstate Dr. Dept PE
West Springfield, MA 01089 (413) 737-5376
A Fee Based Service Company

MR. INVENTOR: America's foremost development firm offers a complete service. For free details, write: Charles S. Prince Co., Inc., Empire State Building, Suite 3308-E, N.Y.C. 10001.

BUSINESS OPPORTUNITIES

I MADE \$40,000.00 Year by Mailorder! Helped others make money! Torrey, Box 316-NN, Ypsilanti, Michigan 48197.

FREE CATALOGS. Repair air conditioning, refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, Texas 75201.

NEW LUXURY CAR WITHOUT COST! Free Report. Codex-ZZ, Box 6073, Toledo, Ohio 43614. (419) 865-5657.

MECHANICALLY INCLINED individuals desiring ownership of Small Electronics Manufacturing Business — without investment. Write: BUSINESSES, 92-K2 Brighton 11th, Brooklyn, New York 11235.

MILLIONS in Mail!!! Free Secrets. Transworld-17, Box 6226, Toledo, OH 43614.

MECHANICALLY INCLINED INDIVIDUALS

Assemble electronic devices in your home. Investment, knowledge, or experience not necessary. Get started in spare time. Above average profits. \$300 - \$600/Wk possible. Sales handled by others. Write for free details.

ELECTRONIC DEVELOPMENT LAB

Drawer 1560 PE, Pinellas Park, FL 33565.

EARN EXTRA MONEY — Homeworkers Needed Stuffing Envelopes! Free Details. Write: Jadeway, Box 186-ZD, Gaines, MI 48436.

ERASE DEBTS with little-known law—create wealth!! Details FREE—Blueprints, No. EE10, Box 900, Bronx, NY 10471.

EARN \$1000 STUFFING 1000 ENVELOPES! Money back guaranteed. Details \$1.00. D. Fraser, 208 S. 4th, DeSoto, MO 63020.

BORROW \$25,000 "OVERNIGHT." Any purpose. Keep indefinitely! Free Report! Success Research, Box 29263 GJ, Indianapolis, Indiana 46229.

SPARE TIME fortune in Vinyl Repair. Huge demand creates exceptional profits. Two small \$20 jobs earn you \$1,000 a month. We supply everything. Details free. VIP, 2012 Montrose, Chicago, IL 61618.

BIG MONEY! Interested? Free disclosure. Febre-V, Box 6073, Toledo, Ohio 43614. (419) 865-5657.

START A CONSUMER ELECTRONICS BUSINESS. Details \$2.00 (refundable). ICBF, P.O. Box 46, Nashville, IL 62263.

SUCCESS and Financial Freedom in Mailorder. Learn professional secrets. Free report. Mandrell, Dept. PE101, Glen-dive, MT 59330.

EMPLOYMENT OPPORTUNITIES

ELECTRONICS/AVIONICS EMPLOYMENT OPPORTUNITIES. Report on jobs now open. Details FREE. Aviation Employment Information Service, Box 240E, Northport, New York 11768.

ELECTRONIC FIELD SERVICE — Nationwide positions. Employer pays fees (312) 398-5535. Field Service Search, PO Box 544, Arlington Hts., IL 60004.

DO-IT-YOURSELF

AUDIO/ANALOG/SYNTHESIS. Plans, parts, kits, etc. for the most exciting sound projects ever. Get on our mailing list, send 25¢ to: CFR Associates Inc., Newton, N.H. 03858.

REAL ESTATE

BIG ... FREE ... FALL CATALOG! Over 2,600 top values coast to coast!! UNITED FARM AGENCY, 612-EP, West 47th, Kansas City, MO 64112.

MICROCOMPUTERS

TRS-80 MICRO COMPUTERS by Radio Shack* at 15% discount! Also have software for business systems. Micro Management Systems, Downtown Shopping Plaza, Cairo, GA 31728. (912) 377-7120.

RUBBER STAMPS

RUBBER STAMPS, BUSINESS CARDS. Many new products. Catalog. Jackson's, E-100, Brownsville Rd., Mt. Vernon, IL 62864.

HYPNOTISM

FREE Hypnotism. Self-Hypnosis. Sleep Learning Catalog! Drawer H400, Ruidoso, New Mexico 88345.

BOOKS AND MAGAZINES

FREE book prophet Elijah coming before Christ. Wonderful bible evidence. MEGIDDO Mission, Dept. 64, 481 Thurston Rd., Rochester, N.Y. 14619.

CB TECHNICIANS — now available — SSB Engineering Practice Manual. Most comprehensive book on how to modify and expand any CB radio for maximum performance and range. Includes the newest PLL radios. Free fact sheet or send \$14.95. SSB Publications, Box 960, Hyannis, MA 02601.

BACK ISSUE MAGAZINES. Free list. Send stamped envelope. Everybody's Bookshop, Dept. ZD, 317 West 6th, Los Angeles, CA 90014.

MOTION PICTURE/VIDEO FILMS

EARLY CHRISTMAS COMEDY FILMS SPECIALS — Place your orders by mail — save energy and \$\$\$\$. W.C. Fields "But Ado About Golf". See Fields battle caddy, ball & club. S8 B&W 200' silent \$9.95 ea*; S8 B&W/Sound \$19.95*. 16mm B&W/sound 400' reel only \$24.95 + \$1.50 ship. Abbott & Costello "Who's on First?" An American baseball classic. S8 B&W Sound 200' reel \$20.95*. 16mm B&W/Sound 400' \$34.95 ea. ppd. "Fabulous Harlem Globetrotters" 16mm color/sound 400' special \$49.95 ea*; 200' S8 Col/sound \$29.95*. S8 B&W sil 200' \$10.45*. Marx Brothers "Pigskin Capers" 400' 16mm B&W/SD \$32.95 ea*; 200' S8 B&W/sil \$9.98*. Sound Values. Woody Woodpecker "Ski For Two" S8 Col/sd 200' \$31.98 ppd.; 16mm Color/sound 400' \$54.99 ea. ppd. "Man On The Flying Trapeze" 200' S8 Col/sd cartoon \$31.98 ppd. "A Christmas Carol" 400' B&W/SD \$42.95 ppd. "World Without Sun" Undersea World of Jacques Cousteau 200' col/sd \$31.79 ea; 200' Col/sil \$20.97 ea ppd. "Where Jesus Walked" filmed in Judea and Galilee 400' Col/sd \$48.99 ppd. *Add 85¢ per film 200' reels. \$1.50 per film 400' subjects. If cartridge add \$1.75 a film. Sportlite cartridge service — 400' films can be ordered in cartridges for automatic projection. Indicate technicolor or fair-child projector. Add \$12.50 for cartridge, \$1.75 UPS. New 45 page glossy Columbia catalog, \$1.25. Exciting Universal 64 page color brochure. \$1.25. Columbia, Universal, Sportlite, Ring Classics order forms, 40¢ ea. SPORTLITE FILMS, Elect-10, Box 24-500, Speedway, IN 46224.

MISCELLANEOUS

MPG INCREASED! Bypass Pollution Devices easily. REVERSIBLY!! Free details — Posco GEE10, 453 W. 256, NYC 10471.

NEW CAR FREE YEARLY! Workable secret method — free information: Supercar, Box 28101-N, St. Louis, MO 63119.

GASOLINE MILEAGE INCREASED DRAMATICALLY! Simplified retuning methods. Details FREE! Techneeing, Box 12191 PE, Norfolk, VA 23502.

FREE PROMOTIONAL ALBUMS, concert tickets, stereos, etc. Information: Barry Publications, 477 82nd Street, Brooklyn, NY 11209.

CORVAIR PARTS — 4500 parts in 300 page catalog: \$3.25. Clark's Corvair Parts, Inc., Shelburne, Mass. 01370.

CLASSIFIED ADVERTISING ORDER FORM

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	30

SIGNATURE _____

PRINT NAME _____

ADDRESS _____

CITY _____ STATE _____

Please refer to heading on first page of this section for complete data concerning terms, frequency discounts, closing dates, etc. WORD COUNT: 15 WORD MINIMUM. Include name and address.

Words _____

\$2.75 Commercial Rate
\$4.10 Expand-Ad Rate
\$1.60 Personal Rate

☐ Insertions _____

☐ Enclosed is \$ _____

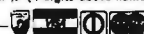
☐ CHARGE: You will be billed monthly.

☐ American Express ☐ Master Charge
☐ Visa ☐ Diners Club

Account # _____

Expiration Date _____

Master Charge Interbank # (4 digits above name) _____



Popular Electronics

ADVERTISERS INDEX

READER SERVICE NO. ADVERTISER PAGE NO.

6	Aaron-Gavin Instruments	87
2	Active Electronics Sales Corp.	119
3	Amelect, Inc.	22
4	American Antenna	Cover IV
7	Amper Electronics Inst. Co., Inc.	125
8	American Electronics	102
9	Anconra Corp.	125
10	AP Products Inc.	79
11	Audio Technica U.S., Inc.	6

12	B & F Enterprises	124
13	B & K Precision, Dynascan Corp.	110
14	Byte	95
	Cambridge International, Inc.	15
	Camelot	9
	Chaney Electronics	131
	Cleveland Institute of Electronics, Inc.	34, 35, 36, 37
1	Communications Electronics	2
16	Computique	131
17	Continental Specialties Corp.	Cover 2
62	Creative Computing Magazine	104
	Crutchfield Corp.	29

18	Delta Electronics Co.	131
19	Digi-Key Corp.	114
	Digital Research Corp.	120
21	DSI Instruments, Inc.	31

22	Exidy, Inc.	10, 11
----	-------------	--------

	Fordham Radio Supply	126
23	Fuji Photo Film, USA, Inc.	14

	GC Electronics	8
24	General Engines Co.	124
25	Godbout Electronics, Bill	126
	Grantham College of Engineering	111

5	Heath Co.	33, 53, 54, 55, 77
26	Hewlett-Packard	Cover 3

27	Illinois Audio	106
29	International Components Corp.	120

30	J & R Music World	96
31	Jameco Electronics	122, 123
	JBL	38
	JS & A National Sales Group	1

32	Kenwood	21
----	---------	----

	McGraw-Hill Book Club	88, 89, 90, 91
33	McIntosh Laboratory, Inc.	85
	Microcomputer Mart	103
34	Micro World	126
35	Mini Micro Mart	96

36	National Locksmithing Supply Co.	82
	National Technical Schools	70, 71, 72, 73

37	Netronics R & D Ltd.	100
38	Netronics R & D Ltd.	101
39	Netronics R & D Ltd.	94
	NRI Schools	16, 17, 18, 19

40	Ohio Scientific Instrument	5
41	OK Machine & Tool Corp.	51
42	Olson Electronics	127
43	Olympic Sales	104
44	Osborne & Assoc.	105

45	PAIA Electronics, Inc.	111
46	PAL "Firestik" Antenna Corp.	82
47	Percom Data Co., Inc.	63
48	Poly Paks	117

49	Quest Electronics	118
----	-------------------	-----

	Radio Shack	81, 121
--	-------------	---------

	Sabtronics International, Inc.	83
50	Sansui Electronics Corp.	23
51	Schober Organ Corp., The	96
60	Selchist	107
	Sharper Image, The	25
52	Shure Brothers, Inc.	69
53	Sony	12, 13
59	Southwest Technical Products Corp.	102
	Speakerlab, Inc.	106

54	Tab Books	7
55	Teknion	108

56	U.S. Pioneer Electronics	59
----	--------------------------	----

57	Vector Electronics Co.	104
----	------------------------	-----

Electronic Warning Flasher Kit

This battery operated device continuously emits bursts of intense light. Great for bicyclists, skiers, boaters & campers. Comes with all parts, quality PC board and easy-to-understand instructions. Uses high-output xenon flash tube which flashes 2 times per second when batteries are fresh.

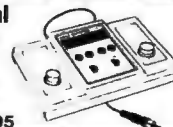


\$6.95

T.V. Game Special

Reject "Video Olympiad" TV game units. Play 3 exciting color TV games, with on-screen digital scoring and realistic sound effects. You repair and save!

\$8.95



Wheel of Fortune Kit

Popular game device uses LED's, transistors & IC to give the effect of a bright red ball spinning around numbers. Unit emits a clicking sound as ball spins and finally stops on a number. Incl. all parts, faceplate & P.C. board.

\$8.99



Strobe Kit

Complete variable rate strobe light kit. Contains all parts, line cord, PC board and instructions. 117V.

\$7.50

6KV Trigger

COIL. To fire xenon flash tubes. 5 tubes, w/ schematics.

89¢

Strobe Tube Assortment

Brand new factory prime strobe tubes. 5 tubes, w/ schematics.

\$3.00

Reject Earradio

Rejected for various reasons. We are offering these sets "as-is" at tremendous savings. We send a block diagram of the radio IC with the reject set. W/O batteries.

\$2.49

Tube Special

6SN7 C23696
7AK7 C23697
12AU7 C23698
12AH7 C23699
12AT7 C23700

YOUR CHOICE:

2 for \$1.00



P.O. BOX 27038, DENVER, CO. 80227 (303) 781-5750
Send for our free giant catalog of unique items!!!

PROFESSIONAL DISCOUNTS

HEWLETT PACKARD

HP-10	\$139.95	HP-38C NEW	134.95
HP-67	CALL	HP-31E	44.95
HP-82	399.95	HP-32E	54.95
HP-97	CALL	HP-33E	79.95
HP-33C NEW	109.95	HP-37E	61.95
HP-34C NEW	134.95	HP-38E	94.95

HP-41C NEW PROGRAMMABLE...CALL

We are HP's authorized franchise dealer - all accessories are professionally discounted

TEXAS INSTRUMENTS

electronic calculators

TI-35 NEW	\$24.95	TI-5025	69.95
TI-50	33.50	TI-5040	89.95
TI-55	34.95	TI-5100	39.95
TI-57	44.95	Programmer	48.95
TI-58C NEW	109.95	MBA	44.95
TI-59	289.95	Business Analyst II	39.95
TI-59/58 Libraries	28.95	Speak & Spell	48.95
TI-30 SP	17.95	Spelling Bee	28.95
SR-40	21.95	DataMan	18.95
PC-100C	146.95	DataCard	24.95
TI-1030	16.95	DataClip	27.95
TI-1750	19.95	Little Professor	12.95
TI-1750	29.95	Travel Alarm	21.95
TI-5015	32.95	Chrono Alarm	69.95

ALSO Casio, Canon, APF, Sharp, Lexicon (NEW), MSC

Saiko, Citizen, Craig, Sanyo, Noricco-Phillips, Pearlcarder, SCM, Olivetti, Record-a-Call, Code-a-Phone

Apple, Atari, Boris, Chesschallenge, Randix

ALL AT GREAT PRICES!

Apple 16K \$995.00

Lexicon LK-3000 \$159.95 (Cartridges Additional Charge)

WE WILL BEAT OR MEET ANY COMPETITORS' PRICE

IF HE HAS MERCHANDISE ON HAND. All units shipped

in original factory cartons with accessories according

to manufacturers' specifications. CALL TOLL FREE

(800) 854-0523 (outside CA) or (714) 549-7373 (within CA).

BankAmericard, Visa and MasterCard; money order; pers.

Ck. (2 Wks. to clear); COD accepted. Min. \$4.95 for shipping

in USA. All merchandise subject to availability. Prices good

with this ad for limited time only. Send mail orders to

DEPT. WRITE OR CALL FOR FREE CATALOG.

computique

3211 South Harbor Blvd., Santa Ana, CA 92704

6 Stores in California - CALL:

(714) 549-7373 (800) 854-0523

Tested 'AA' NICAIDS

SPECIAL BY-MAIL OFFER

Brand new - slight imperfections on case!

Delta No.	Type	Hours	Dimen.	SALE
5688R	1/2A	200	.619dia x .680	88
5688R	1/2A	200	.619dia x .758	88
5676R	AA	200	.545dia x .601	78
5689R	AA	200	.687dia x .198	88
5689R	Sub C	1.2	.885dia x .146	158
5677R	C	2.0	1.06 dia x .147	158
5679R	1/2D	2.3	1.305dia x .1370	198
5678R	D	4.0	1.308dia x .228	278

BUTTON CELLS

Delta No.	Type	Hours	Dimen.	SALE
5685R	1.2	.05	.895dia x .205	158
5683R	1.2	.15	.985dia x .275	78
5684R	1.2	.22	1.136 dia x .308	88
5682R	1.2	.22	1.136 dia x .320	88

100% Guaranteed - Rechargeable

**Have tabs **buttons on both ends

Speaker Cabinet Kit

We've a limited number of assemblies from a famous prestige maker. Photo shows an assembled kit. Speaker case is 10 1/4 x 17 x 9 1/4. Holds a 3 1/2" tweeter, an 8" woofer (not included), and has a 2 1/2" port. Provision is made for a paddle adjustment (not shown). This assembly was used in the maker's \$300 speakers - Case: simulated walnut!

2 for \$26

Delta No. 5715P \$13.95

Above less spkrs

No. 5716P Above less spkrs with grille cloth & paddle assembly, terminal mtg plate \$15.95 2 for \$30.
No. 5672P Tweeter \$3.95 2 for \$7.
No. 5718P 8" Woofer for above \$16.95 2 for \$33.
10" air-suspended speaker \$16.95 2 for \$33.

Featured in April Radio Electronics and Popular Mechanics

Delta Burglar ALARM \$24.50

MOTION DETECTOR... detects any motion for a minimum distance of 8-ft. The secret is in the ultra-complex custom LSI chip which combines the latest in linear & digital circuitry. Completely self-contained in a case 5 x 3 x 2 1/4" and operates from four "AA" Nicad batteries. Nothing else is needed for the device to perform its basic function - motion detection. When movement is detected a "whoop" alarm is sounded. The Delta MOTION DETECTOR is designed to provide either an audible or silent alarm.

Delta No.	Description	Price
5611P	Complete motion detector kit (less batteries)	\$24.50
1072P	Motion Detector Chip only, with data	8.95
5611P	P.C. board, set of 2	4.50
5611P	"AA" Nicad Batteries, set of 4	4.50
5636P	Battery charger for above	3.95
5635P	Completely assembled kit w/batteries & charger	69.50

Miniature Digital Electronic Counter

BRAND NEW GUARANTEED



2 FOR \$3.50

\$1.95

DELTA has 2 models of a digital counter which was designed to help people slow down eating. Here's how it works - when you take a bite you push the button. "1" appears...then 26 visible pulses in which time you are supposed to chew with each pulse. At the end of this cycle the button is pushed again...the number "2" appears...again followed by the 26 pulses. Since this is a 2-digit readout - 99 is the maximum count. There is a control to speed up or slow down the pulse in this unique digital counter with 7-seg. LED readout!

Operates from a 9-Volt transistor battery! Each model does the same thing, but the 2 devices are slightly different in size & construction. The 5708P uses special National Semiconductor chip MM58107N & is 1-3/4 x 1-1/4" W. Both devices have push button ON-OFF switch...2-digit HP or NS displays & 9V battery clip.

Pre Programmed PARTS

No. 6600P-1/4 (1/4-lb).....	\$3.00
No. 6600P-1/2 (1/2-lb).....	\$5.50
No. 6600P-1 (1-lb).....	\$10.00



Would you believe 250-300 (114-lb) of assorted parts for:

Pre-programmed components mounted on reels for use in automatic insertion. These strips consist of a variety of components such as resistors, capacitors, diodes, zeners, etc. Fortunately, we have acquired several 100-lb...all mounted on reels with full leads. Upon examination of these strips we noted there were tantalum capacitors...mostly 5% resistors & many zeners. A sample 1/4-lb. had the following...216 1/4-watt 5% resistors...18 1/2-watt 5% resistors...28 smt signal diodes...30 tantalum capacitors. Not every 1/4-lb assortment is the same.

Add 10% for postage-excess refunded

FREE
120-PC
"SURPLUS"
CATALOG

DELTA ELECTRONICS

176 SECOND AVE.
WALTHAM, MASS.
02154

Minimum Order \$8.00

TEL: (617) 388-4705

Visit our retail at 7 Oakland St., Amesbury, Mass.

CIRCLE NO. 18 ON FREE INFORMATION CARD

ELECTRONICS WORLD®

Personal Electronics News

Sun power counts traffic in Glendale, AZ. It is an electronic vehicle counting system built around low-voltage, low-current microprocessor technology that draws electrical power from a panel of solar cells. The "StreeterAmet MR Traficounter" system counts vehicular traffic in six lanes via six inductive road loops. Lead/gel cells on constant trickle charge from the solar cells serve as backup for the batteries supplied with the Traficounter to give anywhere from 15 to 30 days of power if the sun fails to shine for that long a time.

Algebraic notation loses out to Reverse Polish Notation (RPN) calculator system, according to a study conducted at the State University of New York at Buffalo with 20 test subjects. Furthermore, most people have no idea how their calculators operate or how to use them efficiently, it was found. RPN users had strong preference for their system, claiming greater speed, accuracy, and efficiency. When algebraic-only users were trained in RPN, several subjects informally expressed a desire to buy RPN calculators. It was stated that manufacturers have ignored the thought processes that go on as the user operates the calculator and that, as a result, some calculators appear to be inefficient primarily because the user cannot grasp the internal logic of the calculator.

Private receiving equipment for TV satellite transmissions may be licensed or otherwise regulated by the FCC if the National Association of Broadcasters has its way.

The NAB has filed a petition with the Commission asking that it conduct inquiries and adopt policies before any "widespread proliferation of receive-only earth stations operated by members of the viewing audience" occurs. The NAB claims that such a development could hurt the market for TV programming, threaten the conventional system for relaying TV signals, and adversely affect local video services.

According to estimates, some 5,000 such earth stations, most of which have not been subjected to official FCC procedures, exist. However, there are an estimated 4.2 million households with marginal or

nonexistent TV reception capability--because of location--that are considered to constitute a potential market for receive-only terminal equipment. Cost of a private earth station is said to range between \$1,000 and \$8,000, depending on the signal quality desired.

An ultrathin, "paper" battery has been announced by the Electronic Components Division of Panasonic Company. The new battery is well suited for electronic devices with low current drains (20 to 50 μ A), such as calculators, watches, and cameras, and comes in a wide variety of shapes. It operates in essentially the same manner as a conventional zinc/acid dry cell, except that stainless steel plate replaces the carbon electrode and zinc perchlorate is used in the electrolyte instead of ammonium or zinc chloride, which would attack the stainless steel. Specifications for a battery measuring 70 x 20 x 0.8 mm are: nominal voltage 1.4 V, discharge capability 27 mAh, expected lifetime in a calculator with an LCD display 1000 hours.

Ease in shopping for computers is the goal of a new service implemented by the Southern California Computer Dealers Association. By calling the toll-free number (800) 432-7257 Ext. 815, anyone in the area from San Diego to Santa Barbara can reach the Consumer Computer Information Service. The voice that answers will ask the caller his location and will then supply the names, addresses, and phone numbers of the three nearest computer stores.

A national radio paging network for consumers is being developed by the British Post Office. Hopes are that it will serve about 1.6-million customers by the mid-1980s. The campaign encourages private, rather than business, use of the net. The government initiated its paging service in a 1973 trial in the Thames Valley, where about 2500 customers are currently served. In late 1976, the service was extended to London, where current usage is about 18,000. Thousands of new pagers, purchased from Motorola Ltd., are on order to service the Birmingham and Manchester areas this year.



Step up to excellence. Step up to Series E.

Why settle for anything less than excellence. Especially now that it's available at a very affordable price in Series E from Hewlett-Packard—five precision calculators for science, engineering and business starting at just \$50*.

EXCELLENCE BY DESIGN. Experience the HP difference in Series E: a new larger display with commas for easy reading; built-in diagnostic systems that help catch errors; RPN logic for ease-of-use and efficiency; a complete documentation system—Owners' Manual and Applications Books; plus a host of HP extras—low battery warning light, rechargeable batteries, positive feedback keys, sturdy impact-resistant case. In sum—excellence by design.

A SERIES E FOR EVERY NEED.

Series E gives you more power and features at a lower price than any comparable calculator HP has ever offered.

NEW LOW PRICES:

HP-31E. Scientific. \$50*

HP-32E. Advanced Scientific with Statistics. \$70*

HP-33E. Programmable Scientific. \$90*

HP-37E. Business Management. \$75*

HP-38E. Advanced Financial with Programmability. \$120*

SEE YOUR HP DEALER. For details, send in the coupon or visit your nearest HP dealer. For the name and address, CALL TOLL-FREE 800-648-4711 except from Alaska or Hawaii. In Nevada, call 800-992-5710.

CIRCLE NO. 26 ON FREE INFORMATION CARD



Dept. 254L 1000 N.E. Circle Blvd., Corvallis, OR 97330

HEWLETT-PACKARD

Dept. 254L
1000 N.E. Circle Blvd.
Corvallis, OR 97330

Please send details on Series E:

☐ Business Calculators

☐ Scientific Calculators

Name

Address

City

State Zip

*Suggested retail price excluding applicable state and local taxes—Continental U.S.A., Alaska and Hawaii. Displays photographed separately to simulate typical appearance.

619/17

THE K40 SPEECH PROCESSOR

The K40
Speech Processor.
So unique it's patented.
So good its guaranteed
to out-perform any
microphone on any radio.

CLIPS
ANYWHERE
WITHOUT A CLIP!

Molded four-pole internal magnet clamps instantly to any steel surface. Steering column, metal dash, roof top, or the side of your CB radio. No groping for your mounting clip.

PROCESSES
SPEECH WITH A
COMPUTER CIRCUIT!

It's its own computer—it automatically monitors your speech and adjusts it in micro-second increments pumping so much db gain into your speech that you get 400% more power than a standard mike.

Double Guarantee

GUARANTEE I:

The K40 Speech Processor is guaranteed to outperform any microphone it replaces or return it for a complete and full refund within 7 days from the K40 Dealer that installed and tuned it.

GUARANTEE II:

Unconditionally guaranteed for 12 months. Guaranteed against cracking, chipping, or rusting. Guaranteed against mechanical failure. Guaranteed against electrical failure. No exclusions. No gimmicks. For a full 12 months.

SOUND SENSITIVE
2 INCHES OR 2
FEET!

A microphone so sensitive it will select your voice and process your speech no matter how close or far you are from the microphone.

TWO MICS
WITH ONE
SWITCH!

Switch up for a high-pitched transmission for cutting congested city traffic. Switch down for a mellow base in open, uncluttered rural areas.

NOISE
CANCELLING

Pull the Processor directly to your mouth and speak directly into the mic. The Processor adjusts to your voice—and blanks out all the cab noise while you're speaking. Automatically.

FRESH CHARGE
WITH NO
BATTERIES!

Patented electronic storage system recharges while you listen to the radio. It provides a fresh electrical charge every time you squeeze the trigger. You never replace batteries.

\$42.50*

American Antenna Eign, II 60120

*suggested retail

CIRCLE 30 ON FREE INFORMATION CARD

SOLD AND SERVICED EXCLUSIVELY BY 3,500 REGISTERED K40 DEALERS THROUGHOUT THE U.S. AND CANADA